INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT—1935

AGRICULTURAL BRANCH

Calcutta:
PRINTED AT THE CATHOLIC ORPHAN PRESS
3 & 4, Portuguese Church Street

1936.

10 acres of new planting at Borthetta were completed during 1935, bringing the total area at Borbhetta to 68.6 acres, while that at Tocklai remains at 4.4 acres.

The new area comprises :—

(1). 5.13 acres of Silbhetta dark and light leaf varieties, for comparisons between light and dark leaf varieties under 18 different systems of manuring.

This tea was pruned to 8″, after planting, and a year hence will be pruned at 12″, the prunings being weighed to give an index to the effect of the manures. The manure mixtures will comprise all possible combinations of 20 and 60 lbs. nitrogen per acre, with 0, 20 and 60 lbs. phosphoric acid, and 0, 20 and 60 lbs. potash.

Potash and phosphoric acid have, so far, shown very little effect on mature tea : it is possible that one or both may benefit young tea, and that the effect may vary between light-leaf and dark-leaf varieties. The difference, if any, in response to nitrogen of the two varieties will also be of interest.

We have to thank Mr. F. Yates of the Statistical Department, Rothamsted Experimental Station, for the design of this experiment, which is of the complex type that he has developed, to give great economy of space, and expenditure, together with the maximum of information and accuracy.

(2). 1.56 acres of Lotachapri jat, to be used for trials of different methods of pruning young tea. This area is divided into 42 plots. 21 were planted with uncut tall plants; the other 21 with plants cut to remove all green stems before planting. This has been shown to be good in Ceylon and it is desirable to try it here. Other treatments will be added later, to compare different methods of pruning young tea.

(3). 2.17 acres of Lotachapri jat, in another block not yet assigned to a specific purpose.

(4). 1.16 acres of Deamoolie jat, to be used for trials of the effect of various green manure plants on young tea. This land was cleared and levelled and left clean in early 1932, and has been since kept almost clean. It should now be at a low level of fertility, at which green manure plants should prove efficient.

Nurseries have been established and the clearing and fencing started for the planting of a further 6 acres of tea, after which no further planting will be possible at Borbhetta during the continuance of the Tea Restriction Act in its present form. This area is to be used for a complex experiment comparing 12 different jats of tea, manured and unmanured, and with and without shade trees.

As well as the important comparison between jats, under different conditions, the results will give us an accurate estimate of the effect of shade trees on which no data yet exist; and, further we shall be able to examine the speculative suggestion that leguminous shade trees give little effect on tea receiving a resonable manure dressing annually, although very valuable on otherwise unmanured land. Again we have to thank Mr. F. Yates for valuable assistance in the plan of this experiment.

Other new experiments to be started at Borbhetta in 1936 will include a trial of the effect of boga medeloa, lopped and unlopped, manured and unmanured. These will provide very necessary information on the interactions between nitrogen fixation by a legume and manuring, and between nitrogen fixation and lopping.

Another experiment will attempt to determine the factors of value in cleaning out, the trials including :—

1. Bushes cut across with no cleaning out.
2. Banjhi shoots only removed.
3. Dead wood only removed.
4. Banjhis and dead wood removed.

5. Banjhis, dead wood, and weak or "crossing" shoots removed. This about the average cleaning out in practice.
6. As 5, but in alternate years only.
7. As 5, but only strong shoots left, spaced out to a hand's breadth apart.
8. Stick pruning. In order to get a real distinction from 7, this is rather more drastic than the stick-pruning still practised on some gardens in Upper Assam.

On other areas, experiments to compare the efficiency of various composts with artificial mixtures will be made.

At Borbhetta 2,506 mds. green leaf were plucked from 53.1 acres in 1935 against 2,673 mds. from the same area in 1934.

The 5¼ acres of young tea was only very lightly plucked, in the early part of the season, yielding only 6.2 mds. leaf.

Of the remainder, 28.8 acres increased in yield by reason of increasing maturity or recovery from heavy pruning.

17.5 acres are considered to have differed in 1935 as compared to 1934, only on account of seasonal factors. This 17.5 acres gave 72,956 lbs. leaf against 77,149 in 1934, a drop of about 5%. The loss occurred in the early part of the season; when, however, quality was better than in 1934.

It is of passing interest to observe that on the plots devoted to trials of different quantities of manure the seasonal loss was very roughly a constant quantity per acre, there being a bigger percentage drop according as yield per acre was smaller.

lbs. nitrogen annually	Mds. tea per acre			Loss per cent.
	1934	1935	Loss	
0	7·2	6·1	1·1	15·3
40	11·6	9·9	1·7	14·5
80	15·8	14·3	1·5	9·5
120	18·7	17·2	1·5	8·0

For 1935, the Station's Export quota was sold for Rs. 7,765/8/3 and Production quota at Rs. 5,221/12/-. The green leaf not required for experiment was sold at Rs. 3,072/5/9 giving total receipts of Rs. 16,059/10/- against the expenditure on Borbhetta of Rs. 24,314/5/. Since the cost included the upkeep of 6½ acres of young non-yielding tea, and the planting of 10 acres of new tea, the nett cost of the experimental work at Borbhetta was not high.

Except for the relatively small fraction used for manufacturing experiments, the leaf from Borbhetta is not manufactured. Strictly, yields should be expressed in lbs. green leaf; but this method of expression would render results less easily appreciated. Yields therefore are recorded in the following pages in mds. tea per acre, assuming that 100 lbs. green leaf would give 22½ lbs. made tea.

The statistical methods used were explained in the Annual Report for 1933 (pp. 183 to 186). There was no change in 1935 and the explanation need not be made again, except to repeat that the errors to which the results are liable are indicated by the "difference required for significance" reported.

The "difference required for significance" is "standard error" $\times \sqrt{2} \times t$ for P = .05 (Fisher). The odds, then are 20 to 1 on any difference exceeding that required for significance being due to treatment, and not to chance error.

Pruning.

Trial of unpruned tea.

(1). The Tocklai Clearance.

6 replicates.

In 1935 both sets were pruned, the trial therefore in 1935 is of pruning on one-year-old wood against pruning on two-year-old wood. All were plucked at 6" to the janam.

Yields in 1935 were :—

Pruned on one-year-old wood ... 16.13 mds. tea per acre.
Pruned on two-year-old ,, ... 15.00 ,, ,, ,, ,,
The difference in crop is not significant.

Calcutta and London agreed that the quality of the tea plucked from one-year-old wood was significantly better than that from two-year-old wood. (*Vide* p. 29 of the Report on Chemical Section.)

Over the 16 years during which the trial has now extended total yields have been :—

Annually pruned ... 203.8 mds. tea per acre.
Pruned in alternate years ... 196.2 ,, ,, ,, ,,
This difference again is not significant.

In the first two years of the trial there was a very significant gain from leaving the tea unpruned.

		Tea mds. per acre		Tea mds. per acre.
1920	pruned to 14″ plucked at 27″	4·69	plucked unpruned	11·62
1921	Pruned at 16″ Plucked at 27″	8·89	pruned at 14″ plucked at 27″	8·20
		13·58		19·82

Since then the tea when left unpruned occasionally gave more than the tea annually pruned, when the season was favourable to unpruned tea; but over the last six years, yields have been :—

	Mds. tea per acre	
	Annual pruning	Alternate year pruning
1930	15·54	13·95 (unpruned)
1931	14·82	15·61
1932	15·36	13·73 (unpruned)
1933	14·40	14·25
1934	14·95	12·85 (unpruned)
1935	16·13	15·03
	91·20	85·42
Average	15·20	14·24

The loss in the unpruned years is significant, while yields when both sets are pruned (and plucked alike) are about the same. These later losses from the use of unpruned tea are ascribed to increasing damage to frames from wood-rotting fungi attacking at large snags of dead wood left on the bushes for two years. With annual pruning only small snags are left and these are removed at the end of each year before much harm can be done.

(2). *The Introduction of an Unpruned Year during the Building up of Young Bush.*

Although it is well to avoid cutting on thick wood near the base of a bush (all the tea left unpruned after collar-pruning at Borbhetta and Tocklai still shows large numbers of unhealed wounds, where cut on two-year-old wood at 6″ or 8″ from the collar up to 18 years ago) it is possible to obtain the benefit of increased growth from leaving young tea unpruned only once, or perhaps twice. The following experiment exemplifies this. The block of Rajghur tea at Borbhetta was planted with one-year-old plants in November, 1924, low centred a year later, and plucked at 30″ in 1926. On part of the clearance alternate lines were left unpruned in 1927, while the intermediate lines were pruned between 12″ and 15″. Since then pruning has been the same for both, to 18″ before the 1928 season, 20″ for 1929, 22″ for 1930, 23″ for 1931, 24″ for 1932, 24½″ for 1933, 25″ for 1934 and 25½″ for 1935.

Yields in mds. tea per acre have been :—

Year	Annually pruned	Unpruned in 1927 only then annually pruned
1927	3·84	7·60
1928	5·45	5·87
1929	8·51	9·56
1930	9·52	10·62
1931	12·66	13·64
1932	11·75	12·09
1933	13·34	13·97
1934	14·22	14·78
1935	15·08	15·60
Total	94·37	103·73

Not only was a big gain made in the unpruned year, but the unnecessary removal of leaf and stem from the already small bushes in 1927 had a bad effect for several years. Callus formation over some of the larger wounds made on 2-year-old wood is not even yet complete; but in this case these wounds are high enough in the bush to enable removal if damage occurs, certainly at a loss less than the gain already made.

Although very small, the difference, even in 1933, was still significant (the trials are fifteen times repeated).

Differences in 1934 and 1935 are not significant, but there is not yet any indication of later loss from leaving unpruned in 1927.

Light Pruning—(*a*) cleaning out; (*b*) date of pruning; (*c*) pruning interval.

Each treatment 7 times repeated in 7 blocks of 10 plots each.

Preliminary "treatment totals" equalized.

1935 was the sixth year of similar treatment and completes one cycle of pruning at different intervals (*i.e.*, 3, 4 and 6 prunings in the six years).

Results have been :—

Plot-set.	Interval between prunings.	Cleaned out or not.	Date of last pruning.	Mds. tea per acre			
				1935	1934	Average 1934 and 1935	Average 6 years, 1930 to 1935.
1.	2 years	No	April, 1932 & 1934	14·92	7·78	11·35	9·69
2.	2 ,,	Yes	,, ,, ,, ,,	16·27	8·24	12·26	10·91
3.	2 ,,	,,	June ,, ,, ,,	15·43	7·12	11·28	9·91
4.	2 ,,	,,	Sept. Oct. 1932 and 1934.	13·80	12·62	13·21	11·57
5.	1½ ,,	,,	May 1933, Dec. 1934.	11·79	14·32	13·06	10·55
6.	1½ ,,	,,	July 1933, Dec. 1934.	12·11	15·57	13·84	11·90
7.	1 ,,	No	Dec. 1st annually.	10·27	10·24	10·26	10·32
8.	1 ,,	Yes	,, ,, ...	12·44	12·38	12·41	12·30
9.	1 ,,	,,	January 10th ...	11·24	11·91	11·58	11·38
10.	1 ,,	,,	Febrnary, 19th ...	9·23	9·72	9·48	9·33
	Difference required for significance ...			1·24	1·25	1·20	0·98

Effect of cleaning out.

Here we have two sets of plots for comparison.

Tea annually pruned in December.

Over the 6 years the average increase due to cleaning out is 2 mds. tea per acre, the increase being distributed over the season in the following manner :—

	Average mds. tea per acre over 6 years.								
	To end April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
Cleaned out	0·10	0·42	1·51	1·82	2·28	2·52	2·49	1·14	12·31
Not cleaned out ...	0·04	0·31	1·06	1·42	1·94	2·25	2·25	0·98	10·32
Gain from cleaning out ...	0·06	0·11	0·45	0·40	0·34	0·27	0·24	0·16	1·99

After July the gains from cleaning out are relatively slight. About a maund of the total gain of 2 mds. may be considered to be of distinctly better quality than the average of the season. Under conditions approximating to those of Tocklai, therefore, the cost of cleaning out annually pruned tea is considered amply justified, apart from any consideration of sanitation of the bush. It is considered that the damage to frames from leaving of snags is not yet very great, though this factor is expected to prove of importance in the near future.

Tea pruned in alternate years in April.

Here the gain from cleaning out is less, though still significant. In the case of these two sets of plots, however, loss from failure to clean out is observed only in those years when the tea is unpruned.

In 1930, 1932 and 1934 in which year the tea was pruned, yields were :—

	Mds. tea per acre.		
	Cleaned out	Not cleaned out	Loss.
1930	6·11	6·12	0
1932	6·66	6·58	0·08
1934	8·24	7·78	0·46
Average ...	7·00	6·83	0·17

The bushes were pruned in the growing season (mid-April) and the leaving of more leaves to feed the bushes brought them away more quickly, this early advantage from failure to clean out being about counterbalanced by later losses, presumably from the presence of banjhi shoots.

When the tea was left unpruned in the following year, gain always showed from cleaning out.

Year.	Maunds tea per acre.		
	Cleaned out	Not cleaned out	Gain
1931	11·92	10·49	1·43
1933	14·75	12·45	2·30
1934	16·27	14·92	1·35
Average ...	14·31	12·62	1·69

Effect of date of pruning.

Annual pruning in the cold weather.

This comparison has now extended over 6 years during which results have been, in mds. tea per acre.

Year	Pruning dates		
	December 1st.	January 9th.	February 19th.
1930	10·19	8·87	7·62
1931	13·27	12·16	9·62
1932	13·11	12·04	10·54
1933	12·42	12·06	9·26
1934	12·35	11·91	9·72
1935	12·44	11·24	9·23
	73·78	68·28	55·99

Compared to the crop from pruning on December 1st, the average loss from pruning 40 days later does not quite reach the 5 per cent (odds of 20 to 1) level of significance. Having regard to the fact that a delay of a further 40 days produces a further very definite loss of crop, however, it may be assumed that any delay in pruning produces loss of crop, through the proof of loss from short delay would require extremely accurate experiment.

Late pruning means the utilization of a shorter part of the growing season. Probably a still earlier date than December 1st would be a little better for annual pruning, the actual "best date" varying a little with season, usually about November 15th, when crop begins to be very small.

Where good autumnals are made, this might not be sound policy. For the average Assam garden, autumnals are not so great a consideration as second flush teas, and it is on the early teas that the biggest gain from early pruning is made: for example in 1935:—

Date of pruning	Mds. tea per acre						
	To end May	June	July	Aug.	Sept.	Oct.	Nov.
Pruned Dec. 1st . .	0·41	1·48	1·93	2·14	2·55	2·84	1·09
,, Jan. 9th ...	0·20	1·24	1·59	2·19	2·22	2·72	1·10
,, Feb. 19th...	0·06	0·68	0·95	1·91	1·98	2·51	1·14

Even with the January pruning against the December pruning the loss of about ½ md. of second flush tea is a great consideration. It is not, of course, certain that the second flush teas from early pruning are equal to those from later pruning. Observation gives the impression that the later pruned plots are the worse attacked by the "green-fly stunt". It is hoped that in some future year, it may be determined by separate manufacture whether a gain in second flush quality may do something to counterbalance the loss of second flush crop by late pruning.

Pruning in the growing season.

In every year it is observed that any pruning in the growing season reduces the crop in that year, because the bush is out of action for part of the season during which it will yield leaf. Pruning in February allows a lesser part of the growing season to be used than pruning in December or January, but to prune at any time between April and September puts the bush out of action for a still more heavily yielding part of the year. To prune at any such time annually must produce very great loss of crop which probably never can be recovered. In these experiments, therefore, such dates of pruning were tried only at intervals of 2 years or about 18 months. In the year following that of the pruning there is a tendency to make up the crop lost in the previous year. In early years the loss of growing time is not fully so made up; but, later crops increase presumably because the nitrogen spared, by taking the smaller crop, remains in reserve in soil or bush.

Pruning at intervals of 2 years.

Annual crops in mds. tea per acre.

Year	Pruning dates			Annual pruning Dec. 1st
	April 7th 1930 „ „ 1932 „ „ 1934	June 10th 1930 „ „ 1932 „ 19th 1934	Sept. 9th 1930 „ „ 1932 Oct. 31st 1934	
1930	6·11	4·76	6·41	10·19
1931	11·91	11·42	13·24	13·27
1932	8·21	6·28	7·78	13·11
1933	14·75	14·45	15·60	12·42
1934	8·24	7·12	12·62	13·38
1935	16·27	15·43	13·80	12·44
Total	65·49	59·46	69·45	73·81

Compared to annual pruning there is a loss over the 6 years from pruning in the growing season, but the two-year totals are :—

Year	Alternate year pruning			Annual Dec.
	April	June	Sept./Oct.	
1930 & 1931	18·02	16·18	19·65	23·46
1932 & 1933	22·96	20·73	23·38	25·53
1934 & 1935	24·51	22·55	26·42	25·82

It is clear that all three plot-sets pruned in the growing season are improving relatively to the December-pruned tea.

The June pruning has done particularly badly, yielding significantly less than the April pruning. June appears to be a particularly bad time even for the growing season. The matter is under investigation by the botanist. The comparison with the September and October pruning is not exact: since these plots were not pruned at intervals of exactly two years they have an additional period of growth from September 9th to October 31st, in 1934, and much of the gain during this period probably will be lost in 1936.

Pruning at intervals of about 18 months					
Date of pruning	Mds. tea per acre	Date of pruning		Mds. tea per acre	Annual pruning in December for comparison. Mds. tea per acre
1930, May 10th 1930	5·31	July 31st	1930	4·59	10·19
1931, unpruned	11·74	unpruned		11·85	13·27
1932, Dec. 1st 1931	12·84	Dec. 1st	1931	13·37	13·11
1933, May 10th 1933	7·29	July 31st	1933	7·02	12·42
1934, unpruned	14·32	unpruned		15·57	12·38
1935, Dec. 1st 1934	11·79	Dec. 1st	1934	12·11	12·44
	63·29			64·51	73·81

Over the six years the difference between pruning in May (just before the first second flush) and pruning late in July is not significant; though of the two, the July pruning taking the second flush is greatly preferable. Both lose crop compared to annual pruning in December.

The two cycles of 3 years, so far covered, again show relative improvement in the tea pruned in the growing season.

	May pruning. Mds. per acre	July pruning. Mds. per acre	December pruning Mds. per acre
1930, 1931, and 1932	29·89	29·81	36·57
1933, 1934, and 1935	33·40	34·70	37·24

In the long run it may make little difference to crop how often or at what date the tea is pruned, but the losses already made are unlikely to be recovered. For Assam generally the common practice of pruning annually as soon as autumn crop becomes small, seems unlikely to be improved upon. A greater effort than is common in practice should however be made to finish the pruning early.

For certain other districts it may be preferable to prune at a later date at intervals of two years, as indicated by the experiments at Tulsipara.

Incidentally it may be observed that the age of the wood pruned on makes practically no difference to crop when pruning is on the same date, and following plucking is the same.

Year.	Mds. tea per acre.		
	Age of wood pruned.		
	12 months.	17 months.	19 months.
1932	13·11	13·37	12·84
1935	12·44	12·11	11·79

Similarly it will be observed in the Tulsipara experiments that pruning on one-year-old, or two-year-old wood yields the same crop in the following year.

This also is observed in the experiment at Tocklai first reported, comparing pruning in December at intervals of one and two years respectively.

In order to take full advantage of the benefit of early pruning, it has been suggested that a garden should first be pruned at a rapid rate by merely cutting across without any cleaning out, while cleaning out should follow later.

Time of cleaning out.

In 1933 an experiment was started to determine the effect of delay in cleaning out. The first set of 6 plots was pruned and cleaned out in one operation in early December, the 2nd and 3rd sets of 6 plots being cut-across without cleaning out, on the same date. The second set of plots was than cleaned out 7 weeks later in all three years. The third set of plots was cleaned out, in 1933, not till March 31st, but in 1934 on March 7th and in 1935 on March 13th being in these two years 14 weeks after the first set of plots was pruned and cleaned out in one operation.

	Mds. tea per acre			Average loss from late cleaning out.
	1933.	1934.	1935.	
1. Pruned with cleaning out in one operation ...	11·83	13·06	12·93	...
2. Cut-across on same date as 1. cleaned out 7 weeks later than 1 ...	11·56	12·82	12·46	0·33 for 7 weeks delay
3 Cut-across on same date as 1, cleaned out March 31st. 1933 ; then cleaned out 14 weeks later than 1, in 1934 and 1935 ...	(9·48)	11·71	11·68	1·30 for 14 weeks delay
Difference required for significance ...	0·25	0·47	0·52	

In 1933, when cleaning out was delayed till March 31st (about the peak of the first flush), all the banjhi shoots were growing, it was impossible to decide accurately what should be taken and what left; the bushes did not "fill up" by the end of season, and loss of crop was heavy.

The loss from 7 weeks delay in cleaning out is barely enough to be of practical importance: while the loss even from 14 weeks delay in cleaning out is roughly the same as the loss from 6 weeks delay in cutting across. It is considered therefore, of advantage, where sufficient labour is available, to first cut-across and then clean out after the cut-across is finished. At Borbhetta this pruning in two operations, instead of one, costs about Rs. 3/- per acre more, but as pruning in one operation would leave a period without remunerative work for the labour, the real extra cost is negligible, while crop is increased, particularly the good second flush tea.

Trial of different methods of heavy pruning.

Collar pruning against medium pruning to 18 inches.

Two sets of plots were respectively collar pruned and cut to 18" in early 1928, treatment of both sets having been alike before and since the cutting.

Pruning.	Mds. tea per acre	
	1935	total 1928 to 1935.
Iedium pruned 1928	15·39	79·35
ollar pruned 1928	13·73	58·26

The difference in favour of medium pruning is significant ven in 1935, the eighth year after cutting.

Plucking.

I. *Difference in severity of plucking, the leaf taken being the same in all cases.*

The tea used for previous trials on this subject, from 1927 to 1932 inclusive, was cut back and devoted to other experiments after the end of 1934, when the effect of previous plucking on the coming away after heavy pruning had been determined.

This earlier trial showed that the gains from harder plucking were persistent, the hard-plucked bushes showing no signs of deterioration. The lighter-plucked bushes made the better recovery after cutting back, but there was very little in it (*vide* Annual Report 1934).

This earlier trial was abandoned for two reasons. First, the experiment was not designed to give a high degree of statistical accuracy: and, second, for convenience in demonstration, the bushes under different treatment were in long single lines. This arrangement gave the hard-plucked bushes yielding low weights of prunings, the benefit of the heavy weights of prunings from neighbouring lightly plucked bushes, which probably exercised a considerable, and unfair, influence on their yield. The experiment was therefore transferred to another area of mature tea planted in 1924, divided into 7 blocks of 10 plots of 100 bushes each, each plot having been plucked and weighed separately since 1928.

The yields of all 10 plot-sets, designed for different treatment in 1935, were alike in 1934, and differed very little in previous years.

Below are recorded the results in 1935, the first year of different treatment.

(*a*). Effect of length of initial growth above pruning level before tipping, and

(*b*). Effect of leaving a big (serrated) leaf (once only) above tipping level, against plucking to janam (first, unserrated leaf).

Initial growth inches.	Mds. tea per acre, 1935.				
	Plucked to janam.	Plucked over a big leaf.	Average.	Loss per 2″ extra growth.	Loss from leaving a leaf.
4	14·88	13·11	14·00	...	1·77
6	13·46	11·99	12·72	1·28	1·47
8	12·17	11·03	11·62	1·10	1·14
Average...	13·50	12·04		1·19	1·45

Difference between yields for individual treatments required for significance = 0.63 mds.

Leaving of longer initial growth.

The loss from leaving an extra two inches of growth appears to be less as it is left over higher growth, and less if a big leaf is left than if plucking is to the janam; but these differences between differences are not statistically significant. We can report an average difference per 2″ extra initial growth of about 1.2 mds. tea per acre, or about 9% of the crop.

Leaving a big leaf, once only.

The leaving of a leaf appears to produce smaller losses of crop as the leaf is left over longer initial growth; but again these differences between differences are not statistically significant.

We can report an average loss from leaving a big leaf of 1.45 mds. tea per acre or about 11% of the crop.

The loss from leaving a leaf appears to be greater than the loss from an extra 2″ initial growth. Within experimental error, however, they are alike, and may each be assessed, for the 1935 season, at *about* 10% of the crop, much of which loss falls on the early crop of good quality.

Initial growth.	Mds. tea per acre 1935, to end July.					
	Plucking to janam.			Plucking to leave a big leaf.		
	To end June.	July.	Total.	To end June.	July.	Total.
4″	3·29	2·01	5·30	2·73	1·71	4·44
6″	2·48	1·70	4·18	2·31	1·43	3·74
8″	2·02	1·51	3·53	1·79	1·44	3 23

The lightest plucking against the most severe looses 2 mds. per acre of the tea produced during the season of best quality, though it cannot be assumed, without trial, that the teas were equal in quality with the different styles of plucking. Crops in October and November continued to be larger from the harder plucked bushes, but there was not much in it.

At the end of the season the health and vigour of the bushes appeared roughly inversely proportional to the yield. The most lightly plucked completely and thickly covered the ground and carried big healthy leaves. The hardest plucked showed bare ground between the bushes, and carried small shoots, distinctly attacked by brown blight, and with much die-back. Previous experience showed that all the disease was pruned away, and that the very thin wood came away healthily and vigorously in the following spring.

The losses from more sparing plucking in 1935 are greater than the average of the six years of the previous trial, in which it was observed that losses were heavy in years of bad start, and little in years of good start. 1935 was not a year of good start: the "green-fly stunt" was fairly bad, and early crops were small compared to 1934.

The worse the start of the season the more leaves occur on a given length of new wood, and hence the bush is more "spared" in a season of bad than in one of good start. The botanist sug-

gests that there would be less variation in crop between one year and the next, if plucking were to a defined number of leaves instead of to a defined length of growth. In practice the plucking, for convenience, would still be to a defined length, but this length would vary annually according to the average distance apart of the leaves on a particular section.

(*c*). Two sets of plots were included in this plucking trial which will always be plucked to a defined number of leaves on all shoots, one to leave 3 big leaves, and one to leave 5 big leaves. In 1935 both these proved to be very hard systems of plucking, yielding in mds. tea per acre :—

Plucked to 3 leaves 16.34 : for comparison, 4″ to janam 14.88.

Plucked to 5 leaves 14.08 : for comparison, 6″ to janam 13.46.

Difference required for significance = 0.63 mds.

In 1935, 4″ of new wood carried about 4 leaves, and 6″ of new wood carried about 6 leaves.

The interest of these two sets of plots will lie in the amount of variation between annual crops.

(*d*). *Effect on crop of omitting rains teas of poor quality.*

These trials were included to examine the possibilities of increasing average quality, in the case of gardens whose potential crop is much greater than the permissible crop. Crops to the end of July are usually of good quality. Two sets of plots therefore were plucked hard (4″ to janam) till the end of July to give a big crop. They were then left unplucked during August, and skiffed on August 30th.

In previous trials with skiffing in the growing season to the level of the previous plucking, it was shown (*vide* Annual Report 1931, page 30) that the result of such skiffing after cessation of plucking for 4 weeks was to produce very little crop for the 4

weeks following the skiffing, but as a result of this cessation of cropping for two months, there was no relative improvement of the bush as judged by crops in the following year (*vide* Annual Report 1932, page 154). For the 1935 trials, therefore, in the hope of improving the bush, the skiffing left one big leaf above the previous plucking level on the one set of plots, and on the other set three big leaves above previous plucking level.

The resulting crops in mds. tea per acre from the plots plucked at 4″ to the janam were :—

	Continuously plucked.	Skiffed to leave one leaf (low skiff).	Skiffed to leave three leaves (high skiff).
Up till July 26th	5·30	5·31	5·30
August and September ...	5·56	0·06	0·02
October 4th and 11th ...	1·43	2·22	0·85
„ 18th	0·56	0·31	0·47
„ 25th	0·50	0·13	0·24
November 1st	0·51	0·10	0·12
„ 8th to 29th ...	1·01	1·03	0·57
Total ...	14·88	9·16	7·57

With the low skiff the crop lost is just that which the continuously plucked bushes made while the skiffed bushes were out of plucking. It will be observed that there was practically no pluckable leaf during September and in practice plucking could be entirely dropped, till the end of the fifth week from skiffing. Then for two weeks very big crops are taken, then a moderate crop, then such small crops for the next two weeks that plucking could again be omitted. After that crops are equal to those from continuously plucked tea.

With the high skiff, also, there is no crop during September, then crops are about normal for 3 weeks, after which crops are small only. The high skiff then proves a failure, in respect of crop, unless the effect of it proves to increase next year's crop.

Quality.

Leaf from both sets of skiffed bushes and, for comparison, from the bushes continuously plucked in four different ways, was manufactured separately on 6 occasions during October and November, with the following resulting valuations.

		Calcutta (averages of 6 tasters).		London (averages of 5 tasters).	
		Annas and pies.		Pence.	
Continuous plucking	4″ to janam ...	10- 8·1	10- 8·3	14·28	14·37
	4″ to a leaf ...	10- 8·5		14·47	
	8″ to janam ...	10-11·4	10-11·0	14·57	14·63
	8″ to a leaf ...	11- 0·5		14·69	
After skiffing	low skiff ...	10- 8·1	10- 9·5	14·14	14·48
	high skiff ...	10-10·8		14·53	
Difference required for significance...		0- 2·4	0- 1·7	0·33	0·23

London and Calcutta agree that the leaving of a leaf on the second flush makes no significant difference to autumnal quality, but that the autumnal crop plucked over 8″ is preferable to that plucked over 4″. This, of course, may not be true of second flush tea plucked over long and short growth respectively.

With regard to the teas from the skiffed plots, the high skiffed plots give significantly better teas than the low skiffed plots. This was partienlarly marked on the crops of early October when the high skiffed plots yielded teas full of tip and with some of the character of second flush teas, while teas from the low-skiffed plots at this time were distinctly poor.

II. *Differences due to what is taken above same initial growth. All tipped at 8″ and plucked alike (to janam) till May 8th. All plots plucked weekly.*

Second year of similar treatment; 8 replications.

Plot-set	Style of plucking		Total mds. tea per acre	Average valuations June and July	
				Calcutta 6 tasters annas and pies	London 3 tasters pence
1.	*Superfine plucking* broken back to janam	All shoots of 1 and a bud as far as possible. All shoots of 2 and a bud. Single banjhis. Nothing else	8·10	11- 0·7	14·02
	Fine Pluckings.				
2.	not broken back at all	Only large shoots of 1 and a bud	7·95	10- 9·3	13·39
3.	broken back to janam	All shoots of 2 and a bud	7·90	10-10·0	13·46
4.	broken back to tipping level	Single banjhis. Nothing else	8·00	10-11·7	13·68
5.	banjhi shoots unplucked till they come through. Broken back to janam	Similar except that banjhis not plucked	6·31	10-10·2	13·35
6.	*Medium plucking.*	Only shoots of 2 and a bud and double banjhis	8·20	10- 7·9	13·37
7.	*Coarse plucking.* breaking back unnecessary	Everything taken down to janam except shoots of 1 and a bud	9·86	9-10·3	13·08
8.	*Very coarse plucking.* breaking back unnecessary	Only shoots of 3 and a bud and double or treble banjhis	11·54	8- 9·0	12·19
Difference required for significance ...			0·50	0- 3·9	0·23

Crop.

Fineness of leaf.—There is no significant difference in crop between the superfine, the medium, and three of the fine styles of plucking. The fourth style of fine plucking, plot-set 5, leaving banjhi shoots on the bush, reduces crop greatly.

The "coarse" plucking, which not long ago was the average "fine" plucking of Assam, taking everything grown in a week down to the janam, which on a strict count yields about 30% of shoots of 3 and a bud (still soft) gives about 1¾ mds. per acre more crop, and the "very coarse" plucking yields a still further 1¾ mds. of poor stalky tea.

Breaking back.—There is, in the second year of similar treatment, no significant difference in crop whether bushes are broken back heavily, more lightly, or not at all.

In 1934, crop was rather greater according as bushes were more heavily broken back, but at the end of the season the heavily broken back bushes looked very poor, with much die back, those broken back to the janam looked distinctly better, while those not broken back at all looked very healthy and vigorous. The relative increase in crop in 1935 from the bushes not broken back is ascribed to the increased vigour due to leaving more leaf on them, and, so far, it appears likely that this increased vigour may prove progressive. The bushes not broken back soon carry uneven surfaces, which makes supervision of plucking rather more difficult; but, actually, plucking is more rapid, since no time is wasted in breaking back.

Quality.

Fineness of leaf.—About quality, Calcutta and London tasters are in good general agreement, but disagree in some details. Both make a difference of about 2*d.* per lb. between the extremely fine leaf and the very coarse stalky stuff. This stalky stuff, being mainly from second flush leaf, still had liquor qualities which prevented lower valuations.

Calcutta did not make a significant difference between the "superfine" and any of the "fines", while London significantly preferred the superfine.

Calcutta and London agree that the "medium" plucking is not definitely worse than the average of the "fine" pluckings, in spite of the presence of a very little stalk which was absent from the finely plucked samples. We may assume then that the presence of soft double banjhi shoots is not harmful to quality. That Calcutta and London agree that plot-set 5 on which banjhi shoots are left on the bush does not make better tea than where banjhis are plucked, supports this conclusion. It is interesting that this leaving of banjhi shoots on the bush slows down growth and reduces crop, without improving quality.

Both Calcutta and London agree that the "coarse" plucking produces teas significantly worse than fine or medium plucking; but London makes a small difference, in spite of the presence of a little show of stalk, while Calcutta makes a big difference.

London and Calcutta agree that the "very coarse" leaf produces tea worth about 1*d.* per lb. less than the tea from "coarse leaf" on the basis of the 1935 market.

Breaking back.—Among the styles of "fine" plucking where banjhi shoots are plucked (2, 3 and 4), and only the degree of severity of breaking back varies, London made the heavily broken back significantly better than that not broken back at all or that broken back to the janam. Calcutta places the teas in the same order, but does not make the differences due to breaking back significant. Reports tend to indicate an increase in strength from heavy breaking back, with possibly a decrease in "quality". Perhaps Calcutta allowed more weight than London to the "quality" of the teas not broken back, as an offset to their relative back of strength.

Cultivation.

1. The single plot experiments started in 1922, although the experiments are on large plots, suffer from the normal disadvantage of single plot experiments. We know that no two plots, if treated alike, would yield the same crop, and we cannot guess how great a difference is required to be considered as really due to the difference in treatment.

Among the 19 plots there are four which get identical treatment, a deep hoe and 6 light hoes. These yielded in 1935,—

plot 78	...	13.8 mds.	Singlo planted	1916
,, 85	...	10.9 ,,	Singlo ,,	1918
,, 89	...	11.4 ,,	Matelli ,,	1917
,, 93	...	12.8 ,,	Matelli ,,	1916

The plots are long narrow strips (375 by 50 feet) which were thought likely to sample the soil well.

Comparisons of course should be only between plots with the same jat of bush. Under good treatment (but not under bad) the Singlo variety yields a little better than Matelli. The age of the tea cannot now be making any great difference; but the quality of the work in planting might still be having an effect.

The 1918-planted Singlo was infilled from a poorer nursery than the 1916 planting, after failure of planting seed-at-stake in 1917. The Matelli plants of 1917 and 1916 were planted from equally good one-year-old nurseries.

The difference between the two Singlo plots can be partially accounted for by the fact that plot 78 has one of its ten lines of bushes bordering clean cultivated soil, while all other plots have deep drains on each side. Plot 85 also contains a definite "bad patch" of soil, on which tea grows poorly, such as is present on no other plot except No. 81.

There is no ascertainable reason why plot 93 should yield better than plot 89, and this difference must be set down to some inherent difference in soil, such as might occur between any other

pair of plots. No difference of less than 1.4 mds. per acre therefore can be ascribed to the effect of treatment.

It is possible to obtain additional information by comparing yields towards the end of the experiment, with earlier yields; when, in some cases definite changes are apparent.

Although age of bush is probably now making very little difference, it is better to confine comparisons to plots of the same planting, since plots to be compared are then not too far apart.

The 1916-planted Singlo.

Plot No.	Cultivation.	Mds. tea per acre.		
		Average 5 years 1925-1929	Average 5 years 1931-1935	1935
78	1 deep hoe, 1 forking round collars of bushes, 6 light hoes	11·1	13·1	13·8
79	As 78 but no deep hoe ...	10·8	12·6	12·6
80	Trenched in 1921 and 1922 otherwise like 78 ...	10·0	12·9	13·9
81	As 78, but only 4 light hoes...	7·7	11·3	11·3
82	As 78, but 11 light hoes ...	11·5	12·5	12·6
83	As 82, but 8 rounds of surface scraping (cheeling) substituted for last 8 rounds of hoeing	9·4	12·3	12·4

The conclusions formed on this evidence, comparing each result with that of the "standard cultivation" of plot 78, are :—

Plot 79.—The average difference due to the absence of deep hoeing is so small as to be of little practical importance even if it were definite. In 1935 good rain fell early, and it is very probable that the deep hoe exercised a good effect by maintaining soil cleaner of weeds in the early part of the season.

Plot 80.—Of recent years has yielded just about the same as plot 78. It is probable that earlier yields were reduced as the effect of the trenching.

Plot 81.—In early years, when cover from bushes was little, the bad effect of reduced rains cultivation was greater. In later years, 4 light hoes instead of 6 or more does leave definitely more weeds and it is probable that the effect of reduced rains cultivation is still bad, though much smaller since the bushes have afforded better cover.

Plot 82.—Results here make it appear that, although the result of intensive cultivation was good in early years, yet, eventually some harm is effected. It is more probable however that plot 82 has an inherently somewhat poorer soil than plot 78, although this could not be guessed. It is at any rate clear from this result that light hoeing beyond the point at which jungle is suppressed cannot make much, if any, difference for the better.

Plot 83.—In early years, the scraping was not as effective as hoeing in suppressing weeds and crop certainly suffered. An efficient method of scraping was not at first developed. Over the last 5 years, results from hoeing and scraping have been practically the same in each year.

The 1918-planted Singlo.

Plot No.	Standard cultivation.	Mds. tea per acre.		
		Average 5 years 1923-1929	Average 5 years 1931-1935	1935
85	A deep boe; one forking around bushes; 6 light hoes	7·0	10·7	10·9
86	As 85, but all cultivation with fork-boes	7·8	11·5	11·3
84	Cultivated with English straight handled digging fork, but only 3 times annually, and one forking around bushes ...	3·1	4·7	4·8

The small differences between plots 85 and 86 are considered to be fully accounted for by the presence of a bad patch of soil in plot 85.

There is no reason to suspect plot 84 of having naturally bad soil. The plot carries very poor tea over its entire length. Its treatment was devised to show the effect of very thorough, deep, and relatively frequent soil stirring, without weed suppression.

The soil is broken up to nearly a foot in depth, inverted, and very thoroughly stirred. Between these rounds of cultivation grass grows thickly. It is not coarse grass like thatch : the plots started clean in 1921 and the cultivation has been sufficient to keep out coarse deep-rooting grass. The thick mat of shallow-rooting grass is clearly sufficient to reduce growth of tea very badly, and soil stirring without weed suppression is ineffective.

The 1917-planted Matelli.

Plot No.	Standard cultivation.	Mds. tea per acre.		
		Average 5 years 1925-1929	Average 5 years 1930-1935	1935
89	A deep hoe; one forking around bushes: 6 light hoes	10·0	11·6	11·4
87	As 89, but 11 rounds of surface scraping instead of 6 light hoes	10·3	10·8	11·1
88	A deep hoe, one forking round bushes then only one light hoe when extra manure at the cost of 4 light hoes is applied	7·7	15·7	16·0

Plot 87.—The treatment of this plot was devised to show the effect of suppression of weeds without soil disturbance, after the deep hoe. In early years crops were the same as with light hoeing. In later years when both

supressed weeds almost completely, the apparent difference in favour of light hoeing is small and probably of no significance, but it is possible that some small bad effect has resulted from long continued scraping.

Plot 88.—In 1921 the opinion was formed that weeds did harm by reducing the rate of formation of soluble nitrogen compounds (almost entirely as nitrate). The treatment of plot 88 was devised to test the speculative hypothesis that tea would not be harmed by weeds, if soluble forms of nitrogen were supplied as manure.

In early years the tea on this plot disappeared under tall grasses which had to be sickled in September to enable plucking to go on. After sickling, the tea showed green and healthy, not miserably yellow as tea under thatch normally is. Yield however was greatly reduced; and, on the hypothesis, it must be assumed that the presence of this dense grass reduced the availability of the nitrogen more than addition of 40 lbs. nitrogen as sulphate of ammonia increased it. This in fact, was shown to be the case by estimation of the nitrate in the soil.

As treatment persisted year after year, the coarse tall grass gradually disappeared and was replaced by low-growing shallow-rooted weeds, mainly dhub grass. The sulphate of ammonia being held near the surface, would encourage surface rooting weeds, while the increasing cover of the bushes was assisting. In September 1931 there was practically nothing to sickle and from 1932 sickling was abandoned as unnecessary. The tea bushes had suppressed practically all weeds except a few ferns.

Over the last five years the almost uncultivated plot has averaged 4 mds per acre more tea annually, just about the increase found from an additional 40 lbs. nitrogen where both sets of plots are equally

cultivated. We may assume, then that where weeds are suppressed by other means (in this case, cover from tea bushes), no harm occurs from absence of cultivation.

These two plots, run at the same cost for cultivation and manuring combined, but giving 4 mds. extra tea per acre where manuring is substituted for cultivation, illustrate possibilities of reduction of cost of production.

Differences in favour of the manuring are increasing.

The 1916-planted Matelli.

Plot No.	Standard cultivation.	Mds. tea per acre.		
		Average 5 years 1925-1929	Average 5 years 1930-1935	1935
93	1 ordinary deep hoe: 1 round forking around bushes: 6 light hoes	10·9	12·4	12·8
92	As 93, but with no light hoe and 2 extra forkings around bushes. Sickled in June and September	6·2	10·1	10·5
94	As 93, but deep hoe to 18″ deep (instead of about 7″) ...	10·4	12·4	12·9
95	As 93, but no light hoeing in rains. Weeds sickled in June and September ...	4·5	7·9	8·5

Plot 92.—The most interesting comparison is that with plot 95, which also is uncultivated between the lines but does not have the clean circle maintained around the bushes. This clean circle appears to do some good but not to give the efficiency of cleaning the whole area, illustrated by plot 93. Plots 90 and 91 up till 1929 were treated like plot 92, but received 6 and 12 forkings respectively. Plots 90, 91 and 92 yielded,

and looked, alike. 6 or 12 forkings kept the circle no cleaner than 2 forkings, and the extra soil disturbance did no good.

Plot 90 and 91 were then devoted to other experiments.

Plot 94.—The additional depth of cultivation clearly does no good in normal years of early spring rain, though it does no harm. This 18″—deep cultivation is performed very carefully. No roots are cut, but are practically dissected out of the soil while that is being turned. The cultivation also is performed in such a manner that very little of the subsoil is moved upwards annually, but this plot now has a dark coloured top-soil to 18″ depth.

The lower average yield of 1925 to 1929 is accounted for by a serious drop in crop from the deeply cultivated plot in the year of droughty spring, 1928, which affected yield in 1929 also.

Plot 95.—The absence of weed suppression during the growing season of earlier years reduced crop very greatly, but the effect of the reduced cultivation is not to produce progressive deterioration of the bushes. On the contrary, as the bushes do slowly increase in size under continuous manuring the bad effect of the reduced cultivation is becoming less.

The attempt to obtain information from these plots illustrates the uncertainties attending the use of single plots for experiment.

At the same time, it does appear clear that if any one plot is compared with any other, yield depends upon the degree of freedom from weeds, and any increase in depth, efficiency, or frequency of soil stirring does very little good, if any.

(2). *Trial of light hoeing (stirring the soil) against scraping (cheeling) to suppress weeds without disturbing the soil.*

In 1929, plots 90 and 91 were divided into 10 smaller plots all treated alike (hoed) in 1929, 1930, and 1931. They were

then divided into two sets of five plots each, which had yielded as below in lbs. leaf per plot.

Plot-set 1			Plot-set 2		
1930	1931	total	1930	1931	total
238	259	497	239	260	499
232	241	463	224	248	472
271	300	571	215	272	517
206	238	441	217	247	464
222	247	469	231	260	491
total 1159	1285	2444	1156	1287	2443

These two sets of plots started in 1932 equal in fertility, and further it is seen that there is a strong correlation between yields in 1930 and yields in 1931.

In 1932, 1933, 1934 and 1935 plot-set 1 was light hoed five times per season, sufficiently often practically to suppress weeds. Plot-set 2 was scraped to an extremely shallow depth whenever plot-set 1 was hoed. Neither has had a deep hoe since January 1931.

The following yields were obtained :—

Plot-set 1 hoed		Plot-set 2 scraped	
Total 1932 and 1933	Total 1934 and 1935	Total 1932 and 1933	Total 1934 and 1935
451	522	465	511
437	490	421	456
524	564	515	578
421	454	457	500
418	459	453	492
2251	2489	2311	2537

The "scraped" plots appear to have gained slightly, and they remain just a little cleaner of weeds than the hoed plots.

The difference equivalent to only about 1 md. tea per acre in four years, in favour of the scraped plots is not, however, statistically significant. It is interesting that, so far, no advantage has appeared from the stirring of the surface soil of the hoed plots.

3. The Indo-China plots.

This variety of tea naturally grows strongly and yields very well. It is also being heavily manured (75 lbs. nitrogen per acre), the intention being to observe the effects of reduced cultivation on tea giving such cover as to allow little growth of weeds.

It must be emphasized that results like these shown below can be expected only under thick cover. There are no shade trees.

Each trial is 6 times replicated. Tea planted in 1922 and treated alike till 1932.

The total yields of each set of 6 plots destined for different treatment were alike in 1931.

	Plot-set	Treatment	1932	1933	1934	1935
Normal cultivation A deep hoe and six light hoes.	1.	Deep hoe the day after pruning, to bury prunings as is usual. ...	15·5	18·6	19·4	21·23
	2.	Deep hoe the day before pruning, to leave prunings unburied, to ro on the surface ...	15·1	17·8	18·4	20·91
Reduced Cultivation	3.	Hand weeded only. 4 times per season ...	15·8	19·5	21·0	21·12
	4.	As 3, but with deep hoe to bury prunings in addition ...	14·7	17·6	19·2	19·97
	5.	4 light hoes only. No deep hoe ...	15·0	16·8	18·1	19·21
	6.	Sickled only. No form of cultivation whatever	14·1	16·6	18·1	18·61
Differences required for significance			0·67	1·14	1 11	1·51

It will be observed that the failure to bury prunings (compare plot-sets 1 and 2) has not yet made any difference to crop, which can be accounted significant, although the difference in favour of burying prunings was nearly significant in 1934, and had appeared to be progressive. Seasonal factors may affect differences between these plots. Early crop is less where the prunings are buried, presumably from reduction of the available nitrogen in the soil, while the loss is rather more than made up later. For example, in 1935.

	Mds. tea per acre						
	to end May	June	July	Aug.	Sept.	Oct.	Nov.
Prunings buried ...	1·22	2·59	4·58	4·36	4·12	3·39	0·98
Prunings left on surface ...	1·53	2·67	4·46	4·12	3·91	3·15	0·65

Hand weeding only (plot-set 3) has done quite as well as the intensive cultivation of plot-set 1. In 1932 hand-weeding was expensive. In 1935 there were so few weeds ever present, that their removal was extremely cheap. The addition of a deep hoe to the hand weeding (plot-set 4) showed significant loss of crop in the first three years. In 1935 the loss is less and not significant. This is believed to be a seasonal effect. The loss of crop from deep hoeing falls mainly on the early crop, late crops again being rather better from the deep hoed plots.

Where the comparison entails not only the burial against the non-burial of prunings, but also a deep-hoe against no disturbance of the soil at all, the early loss of crop is great, but is less when good rain falls early in the year. The cutting and disturbance of the mat of surface roots formed on the hand-weeded plots causes suffering from any approach to drought to be greatly intensified. In May 1934 the deep-hoed plots looked very yellow and miserable while bushes on the undisturbed soil were green and flushing. In 1935 this difference in appearance was very much less marked.

	Hand-weeded Plot						
	Mds. tea per acre						
	To end May	June	July	Aug.	Sept.	Oct.	Nov.
	1934						
Without deep hoe ...	1·81	2·98	3·39	4·74	3·44	3·55	1·09
With deep hoe ...	1·14	2·43	3·00	4·61	3·32	3·60	1·09
	1935						
Without deep hoe ...	1·79	2·82	4·40	4·12	3·86	3·24	0·91
With deep hoe ...	1·22	2·41	4·17	4·01	3·94	3·31	0·93

The smaller losses at the beginning of the season, and slightly greater gains at the end of the season, from the deep hoed plots, in 1935 compared to 1934, might indicate the beginning of some benefit from deep hoeing to offset the damage from disturbing roots in dry soil. This will be made clear in future seasons. At present the difference is believed to be a seasonal effect. In 1934, 0.12 inches of rain fell in the critical month of March against 3.5 inches in March 1935 and consequently the damage from disturbance of roots was much less, and recovery of the bushes more rapid in 1935.

Where four light hoes only are given, (plot-set 5) the plots carry a little jungle at times and crop is reduced significantly. Losses however are small.

The plots on which the soil is never disturbed at all (sickled only : plot-set 6) give crops insignificantly less than the plots light hoed four times. The weed growth on these plots is steadily diminishing and it is expected that we shall be able to show plots receiving no attention at all—not even sickling. When that occurs, it is possible that these completely uncultivated plots may make up their present deficit. Although so high yielding, these Indo-China bushes do not afford great density of cover, and permit enough light to reach the soil to allow growth of weeds. The suppression of weeds attained is believed to be associated with the dense occupation of the surface soil by tea-roots.

MANURING EXPERIMENTS.

Nitrogenous Manures.

Different quantities of nitrogen in single and divided doses.

1. Soluble artificials.

10 treatments, each 7 times replicated. Preliminary treatment totals of 1929 equalized. 1935 is the sixth year of continuous similar treatment.

Nitrogen in rotation, two years as sulphate of ammonia, third year as cyanamide. This is to avoid great changes in soil acidity due to manuring. It is desired to measure the effect of the nitrogen alone, undisturbed by the secondary effect of changed soil acidity, and the rotation used has been successful in maintaining soil acidity with little change. Average acidity of soil February 1936:—

Manure per acre	pH of soil water suspension.	pH of neural salt extract.
No manure	5·41	4·24
240 lbs. nitrogen in 6 years ...	5·43	4·29
480 lbs. nitrogen in 6 years ...	5·31	4·26
720 lbs. nitrogen in 6 years ...	5·39	4·29

With each 2 lbs. nitrogen there are applied—

1 lb. phosphoric acid as superphosphate.

1 lb. potash as sulphate (muriate in 1933).

Crops have been :—

Plot-set.	Total lbs. nitrogen annually per acre.	How applied.	Tea mds. per acre.							Average for different total dressings. Tea mds. per acre.	Average gain per 40 lbs. nitrogen.
			1930	1931	1932	1933	1934	1935	Total.		
1	Nil	Nil	7·5	8·2	6·1	7·7	7·2	6·1	42·8	42·8	
2	40	1 Dose in March.....	9·6	10·3	9·3	10·7	11·6	9·9	61·4	61·9	19·1
3	40	20 lbs. „ March.... 20 „ „ June	9·1	10·9	9·7	11·1	11·6	9·9	62·3		
4	80	1 Dose „ March	11·0	13·4	13·5	14·5	16·2	14·6	83·2		
5	80	40 lbs. „ March..... 40 „ „ May	10·9	13·5	13·1	14·3	15·4	14·2	81·4		
6	80	40 „ „ March.... 40 „ „ June	10·9	13·2	13·1	14·0	15·6	13·7	80·5	82·0	19·6
7	80	40 „ „ March.... 40 „ „ July	11·1	13·1	13·4	14·3	16·1	14·7	83·0		
8	120	1 dose „ March....	12·4	15·6	16·0	15·5	18·3	16·9	94·7		
9	120	60 lbs. „ March..... 60 „ „ June	12·4	16·1	16·1	16·8	19·1	17·5	98·3	95·8	14·3
10	120	40 „ „ March..... 40 „ „ May ..... 40 „ „ July	11·3	14·8	15·6	16·1	18·7	17·3	94·3		
Difference required for Significance.			0·55	0·65	0·75	0·78	1·12	0·80	.....	.....	.....

Over the 6 years no significant difference appears whether the manure is applied in one dressing, or in two or three divided doses, neither does the date of application of the second dose make any practical difference. For the same total application of nitrogen, crop increase is practically the same.

Crop increase is proportional to the quantity of nitrogen applied up to 80 lbs. nitrogen per acre annually. 120 lbs. nitrogen per acre gives a still further increase of crop but the increase per 40 lbs. nitrogen is less.

The cumulative effect of the manuring is marked.

	Increased crop mds. tea per acre over no manure						Annual cost of manure per acre (in Calcutta).
	1930	1931	1932	1933	1934	1935	
							Rs. as. ps.
40 lbs. nitrogen ...	1·83	2·42	3·42	3·16	4·40	3·82	16 0 6
80 ,, ,, ...	3·46	5·20	7·19	6·53	8·63	8·20	32 1 0
120 ,, ,, ...	4·69	7·31	9·92	8·42	11·53	11·14	48 1 6
Average per 40 lbs. nitrogen ...	1·66	2·49	3·42	3·02	4·10	3·86	...

Although seasonal factors affect response to nitrogen, the general trend shows a strong cumulative effect. The bush cannot make full use of the nitrogen supplied till it has grown to sufficient size. This may explain the smaller responses per unit of nitrogen from the heaviest doses of nitrogen in earlier years. In 1935 responses are not far from proportional to the quantity of nitrogen applied.

Increased crop over no manure.

40 lbs. nitrogen	...	3.82 = 3.86	− 0.04
80 ,, ,,	...	8.20 = 3.86 × 2	+ 0.48
120 ,, ,,	...	11.14 = 3.86 × 3	− 0.44

Leaf from eight of the plot-sets was manufactured separately on 8 occasions during June and July 1935. Details are given in the report of the Chemical Branch, p. 51.

Average valuations :—

lbs. nitrogen per acre.	Calcutta (6 tasters)	London (4 tasters)
	Annas & pies	Pence.
0	10 11·1	14·43
40	10 9·4	14·32
80	10 7·3	14·06
120	10 7·4	13·94

Both London and Calcutta agree that the difference in value of the teas for an increase of 40 lbs. nitrogen per acre is negligible, but that application of 80 or 120 lbs. nitrogen per acre lowers quality significantly. In 1934, differences in quality for 60 lbs. nitrogen per acre failed to be detected, so that 60 lbs. nitrogen may be taken as about the limit of safety for quality. Even with that dose there must be a slight lowering of quality, but the difference appears too small to be detected by the present market. In practice, moderate manuring appears to increase quality. This effect is believed to be indirect. Unmanured gardens can rarely afford to pluck really fine leaf, and plucking makes a big difference to quality, compared to the small difference due even to heavy manuring. In the above experiments the standard of plucking was very strictly the same for all plots. Unmanured plots gave yellower leaf. Apart from that, shoots from high and low yielding plots could not be distinguised apart. The manured bushes give more shoots from bigger bushes.

2. CATTLE MANURE.

4 treatments 6 times replicated.

Preliminary treatment totals of 1929 and 1930 equalized.

Cattle manure tons per acre.			Mds. tea per acre.				
1931	1932	1933 to 1935 annually	1931	1932	1933	1934	1935
nil	nil	nil	9·12	9·47	8·96	7·67	8·05
5	nil	5	9·57	10·23	10·57	10·33	10·78
10	nil	10	10·10	10·58	11·64	12·85	12·79
20	nil	nil	11·20	11·66	10·58	9·30	8·33
Difference required for significance ...			0·54	0·59	0·70	0·64	0·95

The effect of the 20 tons cattle manure applied in April 1931, and not repeated, was showing significantly till the end of 1934. In 1935 its effect is negligible. Actually, slight increases still showed in the early months of 1935, but the later crops were equal to those from plots never manured.

	Mds. tea per acre.					
	To end June	July	Aug.	Sept.	Oct.	Nov.
20 tons cattle manure in 1931	1·26	1·24	1·38	1·74	2·03	0·68
Never manured ...	1·11	1·13	1·37	1·70	2·02	0·71

This single dose of cattle manure now may be considered to be worked right out. It provided 160 lbs. nitrogen per acre, which has produced the following increased crops of tea in mds. per acre.

1931	1932	1933	1934	1935	Total
2.08	2.19	1.62	1.63	0.28	7.80

It is estimated that the same dressing of nitrogen in artificial form would have produced about twice as much increase at greatly less cost, at Borbhetta.

Cost however varies greatly on different gardens. Where there are cooly-lines which have to be cleaned in any case, it must generally pay well to apply as manure the cattle manure collected, and it is well to compost with it such urine-soaked bedding as is also cheaply available, since nitrogen losses will be reduced. The cost of collection of organic matter in addition to such sources of supply must, however, be carefully watched.

The continuous applications (since 1933) show the following increased crops :—

Tons cattle manure		Tea mds. per acre.					
Annually	Total	1931	1932 (residual)	1933	1934	1935	Total increase
5	20	0·45	0·76	1·61	2·66	2 73	8·25
10	40	0·98	1·11	2·68	5·18	4·74	14·69

As with the artificial dressing, increased crop is not far from proportional to the quantity of manure applied. The cumulative effect of continuous manuring is here again evident. The 1931 sample contained 40 lbs. nitrogen per 5 tons cattle manure; the samples of 1933, 1934 and 1935 averaged over 60 lbs. nitrogen per 5 tons. The above increases in crop may be compared with those from the least efficient and the most efficient concentrated manures on the adjoining block of tea planted from the same nursery at the same time, also receiving 40 lbs. nitrogen in 1931, none in 1932, and 60 lbs. nitrogen in 1933, 1934 and 1935.

Treatment.	1931	1932 (residual)	1933	1934	1935	Total increase
Oilcake	1·95	1·30	2·00	3·60	4·12	12·97
Sulphate of ammonia	2·11	1·05	3·20	5·04	6·27	17·67

The oilcake has produced about 1½ times, and the sulphate of ammonia about twice as much increase as the same quantity of nitrogen as cattle manure, applied at the same time.

It will be observed that, in 1932, sulphate of ammonia, as well as oilcake, show a greater residual effect than the same quantity of nitrogen as cattle manure.

Quality of Nitrogen.

(1). 7 treatments, 7 times replicated in randomized blocks. Here preliminary records were kept; but treatments being randomized within blocks, preliminary treatment totals were not quite equal, and the experimental yields reported are adjusted using the analysis of co-variance.

40 lbs. nitrogen per acre in 1931, no manure 1932, to determine residual effects.

60 lbs. nitrogen per acre 1933, 1934 and 1935.

Yields in mds. tea per acre have been :—

Treatment.	1933	1934	1935	Total	Total increase (3 years)	Annual cost of manuring at present prices. Rs as.
No manure ...	9·12	6·58	6·21	22·91	...	nil
Organic manures.						
Oilcake (rape) ...	11·12	10·18	10·33	31·63	8·72	28- 0
Blood meal ...	11·38	10·96	10·67	33·01	10·10	48-11
Horn meal ...	11·59	11·09	11·45	34·13	11·22	43-12
Soluble artificials.						
Nitrate of soda ...	11·88	10·89	11·01	33·78	10·87	37-2
Calcium cyanamide	12·13	11·24	11·30	34·67	11·76	28-1
Sulphate of ammonia	12·32	11·62	12·48	36·42	13·51	27-1
Difference required for significance ...	0·62	0·64	0·62	1·86		

Oilcake has proved inefficient in each year, compared to calcium cyanamide or sulphate of ammonia. Apart from the oilcake, all other manures were roughly of the same efficiency within the first two years. By the third year sulphate of ammonia has gone definitely ahead of all other manures. In the totals for the three years, blood meal, horn meal, nitrate of soda, and cyanamide are equally efficient within experimental error. Oilcake is significantly less efficient and sulphate of ammonia more efficient than the average of these. The greater efficiency of sulphate of ammonia is ascribed to its power of increasing soil acidity. The relative inefficiency of oilcake can be ascribed only to the failure of some of the nitrogen compounds contained in it to become soluble.

No manufacture of leaf from these plots was made in 1935; but in 1934, all with the exception of nitrate of soda but including the unmanured plots, were manufactured separately on 16

occasions, with the result that, neither in London nor in Calcutta could any difference in quality be distinguished.

(2). 6 treatments, 3 times replicated without preliminary records.

30 lbs. nitrogen per acre 1920 and 1922 to 1931.

80 lbs. nitrogen per acre 1932, 1934 and 1935.

No manure in 1921; or in 1933 when the bushes were cut back.

In early years there were big differences between yields from replicates of the same treatment. Of late years, there has been good agreement, so that differences between averages become significant. Early differences in yield must have been due to differences in the soils' natural content of available nitrogen, while all have now fallen roughly to the same level.

	Mds. tea per acre, 1935.	
	Total crop.	Gain.
No manure	5·01	...
Sinews and hide	6·50	1·49
Nitrate of soda	8·58	3·57
Oilcake (rape)	9·66	4·65
Green cuttings of boga medeloa (Tephrosia candida)	10·18	5·17
Sulphate of ammonia	11·22	6·21
Difference required for significance	1·23	...

Oilcake and boga medeloa cuttings (grown away from the land to which applied) yield alike within experimental error. All other differences are significant or on the verge of significance.

The continuous application of nitrate of soda has spoilt the tilth of the soil, as has been demonstrated by physical tests. In early years nitrate of soda did quite as well as sulphate of ammonia.

Plots to which sinews and hide have been applied continuously also have lost tilth to a lesser extent, this being ascribed

to the action of gelatin as a protective colloid. The main cause of the inefficiency of this material, however, must be the unavailability of the nitrogen compounds contained.

As in the other trial just quoted, oilcake does not came out well compared to sulphate of ammonia. There is no indication of lost tilth in the soils to which oilcake has been applied, but no improvement can be demonstrated.

The green cuttings do at least as well. This is rich material containing 1% nitrogen in the fresh state, or about 3% in the organic matter. Such nitrogen is rapidly and efficiently available, and is very unlikely to benefit by the composting which has been recommended in some quarters for cuttings of green crops. Here again, no improvement in tilth or in organic matter content of the soil can be demonstrated, yet.

Sulphate of ammonia has proved more efficient than the other manures tried. It has greatly increased the acidity of the soil, which probably explains its greater efficiency. There is no loss of tilth on these plots to which sulphate of ammonia has been applied for so long. On the contrary, it has been demonstrated by physical tests that the friability of the soil has been improved.

Trial of (a) manures supplying ammonia as phosphate.

and *(b) the use of a single big dose of manure for rapid improvement of poor tea.*

The Light-Leaf Mesai-Plots at Borbhetta.

These consist of 54 small plots of only 1/50th acre each. As yields of individual plots varied very greatly, and were all very small, the area was divided into 9 blocks of 6 plots each, and only 6 trials conducted, each repeated 9 times.

In 1931 one plot-set was left unmanured and the other five used for trials of manures providing phosphoric acid in the form of phosphate of ammonia, nicifos and ammophos, against mixtures of sulphate of ammonia and superphosphate.

Sulphate of ammonia consists of 25.7% ammonia, the balance being sulphuric acid to keep it solid. The sulphuric acid sometimes has a value of its own, but not much, and generally it involves unnecessary freight. Superphosphate simi-

larly contains 20% phosphoric acid; the balance being mainly lime in combination with it, and sulphate of lime, again generally useless.

By combining the phosphoric acid with the ammonia, freight on the useless "carrier" is saved.

These modern materials also have advantages in reduced tendency to cake, and in not causing the containing bags to rot as superphosphate mixtures do. Thus an extra charge of Rs. 5/- per ton for double bags is saved, and trouble of breaking up a caked mixture on arrival at the garden at least greatly reduced.

It was shown in 1931 that all the mixtures were of equal efficiency for the same quantity of nitrogen, whether sulphate of ammonia and superphosphate, ammophos or nicifos were used.

In 1932, the trial was continued, using only one form of phosphate of ammonia (Nicifos), together with nitrate of potash, against the normal mixture of sulphate of ammonia, superphosphate, and muriate of potash, but increasing the dressings in 1932 from 40 to 80 lbs. nitrogen on two of the plot-sets, and to 160 lbs. on another plot-set. In 1933, 1934 and 1935 all manured plots had only 40 lbs. nitrogen in the different forms.

The following have been the results :—

Plot-set	Manuring lbs. nitrogen per acre					Phosphoric acid as	Potash as	mds. tea per acre			
	1931	1932	1933	1934	1935			1932	1933	1934	1935
1.	Nil	Nil	Nil	Nil	Nil	...	...	4·71	5·39	5·37	4·58
2.	40	40	40	40	40	nicifos	nitrate	6·85	8·26	9·27	7·78
3.	40	40	40	40	40	super	muriate	6·52	8·08	8·86	7·45
4.	40	80	40	40	40	nicifos	nitrate	7·44	8·90	9·65	7·91
5.	40	80	40	40	40	super	muriate	7·88	9·36	9·91	8·56
6.	40	160	40	40	40	nicifos	nitrate	9·14	10·64	11·09	9·20
Significant difference :—						...	...	0·70	1·10	0·70	0·76

(*a*). Trial of nicifos against superphosphate and sulphate of ammonia.

Plot-sets 2 and 4 receive nicifos and nitrate of potash;

Plot-sets 3 and 5 receive sulphate of ammonia, superphosphate and muriate of potash.

	Average yields (*mds. tea per acre*)			
	1932	1933	1934	1935
Nicifos mixture (2 and 4)	7·15	8·58	9·46	7·84
Sulphate of ammonia mixture (3 and 5) ...	7·20	8·72	9·38	8·00
Difference required for significance ...	0·49	0·78	0·49	0·54

For the same quantities of nitrogen, phosphoric acid and potash, there is no difference in yield due to the different forms in which the constituents are applied.

(*b*). The effect of a big dressing of manure applied once only.

lbs. nitrogen per acre, in 1932	Increased yields over unmanured plots mds. tea per acre				
	1932	1933	1934	1935	Total
40 lbs. (average of plot-sets 2 and 3)	1·97	2·58	3·69	3·03	11·27
80 lbs. (average of plot-sets 4 and 5)	2·95	3·54	4·41	3·67	14·57
Difference due to extra 40 lbs. nitrogen applied in 1932 only	0·98	0·96	0·72	0·64	3·30
Difference required for significance	0·49	0·78	0·49	0·54	...

Similarly the 160 lbs. dose in 1932 shows long-lasting effect compared to the 80 lbs. dose.

lbs. nitrogen per acre in 1932	Increased yield over unmanured plots mds. tea per acre				
	1932	1933	1934	1935	Total
80 lbs. (average of plot sets 4 and 5)	2·85	3·54	4·41	3·67	14·47
160 lbs. (plot-set 6)	4·43	5·05	5·72	4·62	19·82
Difference due to 80 lbs. extra nitrogen applied in 1932 only ...	1·58	1·51	1·31	0·95	5·35
Difference required for significance	0·61	0·95	0·61	0·66	...

During 1933, 1934 and 1935, all manured plots have received the same treatment. The differences in yield for these years, are due only to the difference in manuring in 1932.

That additional manure in the form of soluble artificial applied in 1932 should produce significantly increased crop over four succeeding years, is a matter of great interest and importance.

From these experiments it is clear that a large dose of soluble artificial may be used without fear to restore a bad patch of tea to profitable yield, the higher level reached being maintained by normal moderate manuring.

Value of tea prunings as manure.

Four trials four times replicated in randomized blocks. Experimental yields adjusted using analysis of co-variance.

1st year of treatment.

Treatment 1.—Prunings buried with deep hoe in January. Artificial mixture in March to supply 40 lbs. nitrogen, 20 lbs. phosphoric acid and 20 lbs. potash.

Treatment 2.—As 1, without artificial.

Treatment 3.—Prunings removed before deep hoe. No artificial.

Treatment 4.—Prunings removed before deep hoe. Artificial as for treatment 1.

	Mds. tea per acre 1935.		Average.
	With artificial.	Without artificial.	
Prunings buried	12·42	10·29	11·35
Prunings removed	11·77	9·17	10·47
Average	12·14	9·73	

Difference between averages required for significance = .496 mds.

The average gain of 0.88 mds. due to burial of prunings is therefore significant.

The prunings appear to exercise greater effect in the absence of the artificial than in its presence, but this "interaction" is not significant: within experimental error the sum of the separate effects of prunings and artificial is equal to the effect of the two used together.

The prunings are estimated to have supplied 1½ tons of dry organic matter per acre, containing 60 lbs. nitrogen.

40 lbs. nitrogen as artificial produce 2.41 mds. tea.

60 lbs. nitrogen as prunings produce 0.88 mds. tea.

The prunings therefore are very slow-acting and probably inefficient as sources of nitrogen as manure. Part of the nitrogenous matter probably remains in the soil to increase its organic matter content. The provision of so much organic matter as prunings may account for our failure to obtain any evidence of advantage from the use of any additional form of organic matter as manure.

In future years it will be interesting to observe the action of sulphate of ammonia on a soil receiving no organic matter at all. On the plots from which prunings are removed, fallen

leaves also are picked up, while no weeds are allowed to grow on any of the plots.

With this quantity of prunings there was no indication of any depression of tea crop at any time.

Trial of Tea Waste as Manure.

The only tea available for this trial was 7 years old and had already received 200 lbs. sulphate of ammonia per acre in March 1935. It is unlikely that young tea on fairly good soil already manured could make much use of further supplies of nitrogen and the apparent failure of the tea-waste and the very small effect of the sulphate of ammonia used for comparison are probably to be ascribed to this cause.

6 trials, 6 times replicated in randomized blocks, yields in 1935 up to July 11th being used as preliminary yields. Final yields adjusted using the analysis of co-variance. All manures applied on June 19th. Previous trials show that they could not show effect before July 18th.

The actual quantities of nitrogen applied per acre were:—

As sulphate of ammonia	...	30 lbs.
As 7½ mds. tea waste	...	22.7 lbs.
As 15 mds. tea waste	...	45.4 lbs.

Mds. tea per acre July 18th to November 28th inclusvie.

	Tea waste mds. per acre 0	7½	15	Average per 18 plots
Without sulphate of ammonia	7·19	7·47	7·31	7·32
With sulphate of ammonia	7·87	7·79	7·96	7·87
Average per 12 plots ...	7·53	7·63	7·63	

Between averages of 12 plots a difference of 0.16 mds. would have constituted a significant difference; but, although so accurate, these experiments fail to show any good effect to be due to

tea waste. The difference due to the small dose of sulphate of ammonia is significant, but very small compared to the average effect of such a dose.

We may conclude that tea waste is less efficient than sulphate of ammonia as manure, but not that tea waste has no value as manure. Cropping of these plots will continue in 1936, without further addition of manure, to see whether the effect of the manures applied in June 1935 then shows up.

Trial of green crops.

4 trials replicated in 8 blocks of 4 plots each.

Preliminary treatment totals of 1933 equalized.

Plot-set.		Mds. tea per acre.		lbs. nitrogen per acre buried in 2 years.
		1934	1935	
1	No nitrogen	9·21	7·90	*nil*
2	Cowpeas sown in March between every row, hoed in at end of May, in 1934 and again in 1935 ...	9·23	7·97	58
3	Boga medeloa sown in March 1934 between alternate rows of tea. Resultant hedges kept rigorously lopped up the sides and across the top at 5 ft., throughout 1934 and 1935. Loppings were buried immediately after weighing and sampling	8·56	8·20	153
4	30 lbs. nitrogen per acre as sulphate of ammonia applied March 1934 and again in March 1935 ...	9·82	9·56	60
	Difference required for significance	0·32	0·37	...

All plots received a basal dressing of 40 lbs. phosphoric acid as basic slag and 40 lbs. potash as sulphate in 1934 only. Without this dressing green crops grow very poorly at Borbhetta. With it, fully average crops of cowpeas and boga medeloa were grown.

Sulphate of ammonia. The small dose of artificial produces significantly increased crops particularly in the second year. The tea, then, was in condition to take nitrogen, if it could get it. If the green crops fail to produce increased tea crop, it must be because they fail to supply available nitrogen to the soil.

Cowpeas. Good crops of cowpeas were grown which contained at the time of hoeing in, practically as much nitrogen as was supplied as sulphate of ammonia, yet the increase in tea crop is negligible in both years. Cropping will be continued without further addition of manure, to make certain that no long distance residual effect from the cowpeas appears; but no effect is now expected from manure which has failed to show any effect for so long. No good effect on tilth is apparent in the soil in which 6 tons per acre of green stuff has been buried; and, if there were any such effect, it would be of no value unless it produced increased crops of tea or better tea.

Weekly crops of tea over the two years were equal within experimental error, though there were indications of increases in the 4th and 5th weeks after the burial of the cowpeas. The most probable explanation of the failure of the cowpeas to do good is that, sown in spring on soil rich in nitrates, no nitrogen was fixed from the atmosphere, and that the nitrogen buried as cowpeas was merely returned to the soil from which it was taken and represented no fresh addition.

Further trials are to be made among young tea with several such ground crops allowed to grow for much longer periods. The more mature plants may fix nitrogen from the atmosphere, particularly as they will occupy the soil at seasons when soil nitrate concentration is very low.

Boga medeloa. Over the two years during which the boga medeloa has occupied the soil, it has produced a loss of tea crop of 0.35 mds. tea per acre, which loss is within experimental error. There has however been no gain from the use of boga medeloa. In the first year of growth, loss of tea crop from the plots under boga medeloa increased as the boga medeloa grew bigger, and the total loss for the season was significant. In the

second year very large quantities of loppings were buried, and a gain not quite significantly great was made.

Throughout the season gain appeared a few weeks after loppings were buried, followed by loss as the boga medeloa grew more leafy.

Mds. tea per acre, 1935.

	No manure	Boga medeloa	Probable explanation of difference due to boga medeloa
To April 18th. ...	0·06	0·08	Residual effect of loppings buried Sept. 1934
April 25th., May 2nd and 9th.	0·18	0·12	Loss due to burial of loppings on April 11th.
May 16th., 23rd., and 30th.	0·27	0·40	Gain due to burial of loppings on April 11th.
June 6th.	0·14	0·14	Gain ceases
June 13th. and 20th. ...	0·36	0·28	Loss due to growth of boga medeloa among tea.
June 27th. and July 4th ...	0·49	0·43	Slight loss due to burial of loppings on June 18th.
July 11th. ...	0·28	0·28	Loss ceases
July 18th., and 25th. ...	0·65	0·85	Gain due to burial of loppings on June 18th.
August 1st. to 29th. ...	1·83	1·84	Gain from previous manuring counterbalancing losses from growth of boga medeloa.
Sept. 5th., 12th., and 19th.	1·00	0·89	Loss from growth of boga medeloa exceeding gain from past manuring with loppings.
Sept. 26th., and Oct. 3rd.	0·72	0·57	Loss accentuated by effect of burial of loppings on Sept. 19th.
Oct. 10th., 17th., 24th., and 31st.	1·34	1·74	Gain due to burial of loppings on Sept. 19th.
Nov. 7th., 14th., 21st. and 28th.	0·60	0·57	Effect of growth of boga medeloa counterbalancing gain from past manuring with loppings.

At the end of 1935 the tea under boga medeloa was holding its own in crop, and it certainly looked better than the tea on the corresponding unmanured plots; though the bushes are rather lop-sided, growing strongly on the side against the line where loppings were buried, and weakly on the side against the boga medeloa hedge.

These hedges were reduced to bare sticks, 5 feet high, by cutting away the sides, and across the top on each of the three occasions on which they were lopped.

On each occasion, the loppings were weighed and carefully sampled before burial on the plots on which they grew.

April 11th.—Total weight of fresh green matter 3,616 lbs. per acre consisting of—

	Containing per cent			
	Moisture	Ash	Organic matter	Nitrogen
1791 lbs. leaf	62·71	2·39	34·90	1·52
680 lbs. green stem ...	70·77	1·99	27·24	0·73
1145 lbs. woody stem ...	60·86	1·36	31·38	0·52

The average composition of the mixed stem and leaf at the time of cutting was:—

Moisture	...	63.64 %.
Ash	...	1.99 %.
Organic matter	...	32.44 %.
Nitrogen	...	1.057%.

38.2 lbs. nitrogen per acre were hoed in as loppings.

June 18th.—Total weight of loppings 4,313 lbs. per acre consisting of—

	Containing per cent			
	Moisture	Ash	Organic matter	Nitrogen
2877 lbs. leaf	72·59	1·53	25·88	1·03
781 lbs. green stem ...	75·53	1·26	23·21	0·38
655 lbs. woody stem ...	66·71	1·07	32·22	0·34

The average composition of the mixed stem and leaf was :—

Moisture	...	72.22 %.
Ash	...	1.41 %.
Organic matter	...	26.37 %.
Nitrogen	...	0.807%.

34.8 lbs. nitrogen were hoed in as loppings.

September 18th.—Total weight of loppings 5,232 lbs. per acre consisting of—

	Containing per cent			
	Moisture	Organic matter	Ash	Nitrogen
Leaf 2977 lbs. ...	69·25	29·20	1·55	1·46
Green stem 816 ,, ...	71·63	26·97	1·40	0·89
Wood ,, 1439 ,, ...	64·28	34·70	1·02	0·68

The average composition of the mixed stem and leaf was :—

Moisture	...	68.35 %.
Ash	...	1.38 %.
Organic matter	...	30.27 %.
Nitrogen	...	1.157%.

60.5 lbs. nitrogen were hoed in as loppings.

Total nitrogen hoed in as loppings :—

1934	...	20.0 lbs.
April 1935	...	38.2 ,,
June 1935	...	34.8 ,,
September 1935	...	60.5 ,,
Total	...	153·5 ,,

The boga medeloa will be left up to provide shade during the cold weather 1935-36, and will be again lopped in early 1936, after which the woody parts will be removed.

In 1936, in the absence of the depressing effect, on tea crop, of the presence of growing boga medeloa in the tea, it is expected that definite gains in tea crop will appear.

In connection with the use of boga medeloa, which appears so valuable in practice, several unsolved problems remain. Further information will be sought, on another block of tea, using boga medeloa, lopped and unlopped, manured and unmanured. Either manuring or lopping may be found to affect the efficiency of fixation of nitrogen.

Trial of (a) application of artificial manure without following cultivation to cover it.

(b) autumn against spring manuring.

Four treatments, four times replicated with preliminary records.

First year of treatment.

Plot-set.	Treatment.	Mds. tea per acre.			
		1934 Oct. 20th to Nov. 31st.	1935 to end June.	1935 July end to Nov.	Total.
1	Manure broadcast on March 25th 1935, soil not cultivated at all till May 20th.	2·22	2·44	11·30	15·96
2	Manure broadcast on March 25th 1935, and covered at once by light hoe.	2·24	2·40	11·21	15·85
3	Manure broadcast and covered by light hoe, on October 6th 1934 and again on October 25th 1935.	2·81	2·61	10·68	16·10
4	No manure	2·29	1·94	8·33	12·56
	Difference required for significance.	0·17	0·18	0·88	1·20

(*a*). Comparison between the results from plot-sets 1 and 2, shows that nothing was lost by failure to cover the manure, in 1935. Conditions however were very favourable to the trial. Good rain fell the day after application, under which conditions no loss would be expected from broadcasting a soluble manure, on flat land, without any other method of mixing with the soil. The dangers of failure to incorporate even a soluble manure with the soil are that it may be removed by high wind if the weather is dry, or that it may be washed by very heavy rain from high to low spots and possibly into drains.

It will require several years of trial before it can be certain that a hoe may be saved, after manuring clean soil, under average conditions. It is however already considered that it would be safe to broadcast soluble manures, on clean flat land, with no following cultivation, if the soil were moist at the time of broadcasting.

(*b*). Autumn compared with spring manuring.

It has been suggested that in districts liable to drought, the valuable early crop is reduced, not only by shortage of water, but by the delay in coming into action of the manures, which cannot be taken by the bush till the soil has sufficient water. The manure was applied to plot-set 2 on October 6th, 1934. Yields from these plot-sets had been practically equal up to that date, but from the October-manured plots yields increased definitely from October 27th onwards.

In the early crops for 1935, the October-manured set continued slightly but definitely ahead of the March-manured plots, but fell behind later.

The autumn manuring therefore has shown a slight advantage in producing rather better crops at quality seasons of the year, though total crops are equal. In 1935 the spring rain (in March) was very favourable. It is possible that greater relative advantage may appear from autumn manuring in years of spring drought, and may do something to assist recovery of bushes which have suffered from drought.

The autumn dressing of 1935 was delayed till October 25th, in the hope that the effect on the second flush teas in the following year might prove greater. In 1935, 0.15 inches of rain fell in October and 0.37 inches in November. The manure was applied to dry soil which remained dry, and the manuring of October 1935 failed to show any effect during the 1935 season. That there probably was some small good effect is indicated by the fact that while the October-manured plots yielded less than the March-manured plots in August, September and October, they rose to equality of yield in November. It will now be interesting to observe the behaviour of these plots in 1936.

Potash and Phosphoric Acid.

1. 16 *treatments*, 8 *times replicated.*

Preliminary treatment totals of 1930 *equalized.*

Fifth year of continuous similar treatment.

	Mds. tea per acre 1935.				
	lbs. potash per acre. 0	15	30	60	Averages.
lbs. 0	12·45	...	12·80	12·84	12·70 for no phos: acid.
Phosphoric 15	12·38	12·72	12·47	12·68	12·56 „ 15 lbs. „ „
Acid 30	12·69	12·74	12·99	12·94	12·84 „ 30 „ „ „
Per acre 60	12·84	12·45	13·00	13·30	12·90 „ 60 „ „ „
Average	12·59 for no potash	12·63 for 15 lbs. potash	12·81 for 30 lbs. potash	12·94 for 60 lbs. potash	

Difference between yields from individual treatments required for significance = 0.906 mds. tea per acre. None of the differences are significantly great.

The sixteenth set of 8 plots has received no manure at all. In 1935 this yielded 7.77 mds. tea per acre. This yield is

increased, in the fifth year of continuous annual application of 40 lbs. nitrogen, alone, by 12.45 less 7.77 mds. = 4.68 mds. tea per acre at a cost for manure (in Calcutta) of about Rs. 10/4/- for 195 lbs. sulphate of ammonia at Rs. 117/- per ton. Even if we could account significant the additional increase of 0.85 mds. from the use of 60 lbs. phosphoric acid and 60 lbs. potash, the additional cost of the dressing is Rs. 18/- per acre, which cannot show a profit.

In 1933 and 1934 significant increases in crop did appear from the use of potash and phosphoric acid together, though not from either alone. These increases however were very small, and over the five years during which the experiment has progressed, the cost of the use of potash and phosphoric acid has been greatly in excess of the value of the increased crop.

Probably at some time in the future, the soil's natural contents of potash and phosphoric acid will be sufficiently depleted to render artificial additions necessary, but until this occurs costs may be reduced by relying on nitrogen alone, as far as crop is concerned. Borbhetta is more deficient in potash and phosphoric acid by any analytical test than nearly every other tea soil of which we have record, and crops other than tea show marked responses both to potash and phosphoric acid on it, yet the unassisted soil appears able to supply the 25 lbs. potash and 10 lbs. phosphoric acid annually which are estimated to be removed by the crop of tea taken.

With regard to the effect of potash and phosphoric acid on quality, no experiments were made in 1935. The question is to be very thoroughly examined in 1936. In previous years valuations have been slightly greater for the teas grown with phosphoric acid than for the teas grown without it, and although the difference was not proved to be significant, it is recommended that a little phosphoric acid should continue to be used in order to be on the safe side; but the cost of the phosphoric acid must be additional to that of the essential nitrogen. Phosphoric acid must not be applied at the cost of the nitrogen estimated to be necessary to produce the permissible crop.

With a normal dose of 40 lbs. nitrogen per acre, 20 lbs. phosphoric acid probably are enough and may be supplied as 50 lbs. concentrated superphosphate which at Rs. 140/- per ton costs Rs. 3/2/-, in Calcutta.

An expenditure of Rs. 13/6 per acre to supply 40 lbs. nitrogen and 20 lbs. phosphoric acid, instead of Rs. 10/4/- for the nitrogen only, may be justified; but if 40 lbs. nitrogen are required, it would not be sound to spend Rs. 3/2/- on phosphoric acid and Rs. 7/2 to provide only 28 lbs. nitrogen. Where manuring costs must be strictly limited, the expenditure must be on nitrogen alone. The effect of the nitrogen on crop is certain, that of the phosphoric acid on quality very doubtful.

With regard to potash, the evidence to date indicates that small doses make no difference to quality, while doses of 60 lbs. per acre reduce quality slightly. As its effect on crop is so small there is therefore good reason to save all expenditure on potash for the present, at least where normal moderate dressings of nitrogen are used.

2. Another set of plots has been manured with and without potash, phosphoric acid, or both since 1922. These are replicated only four times without preliminary records, and the experimental error is so high that the results must be looked upon as of little more than qualitative interest.

If however potash, phosphoric acid or both had any considerable effect, results from them would have shown up by now.

The actual yields in 1935 were :—

	Mds. tea per acre		
	without lime	with lime	average
No potash or phosphoric acid ...	14·07	14·16	14·11
Potash only	15·02	13·42	14·22
Phosphoric acid only	14·62	13·82	14·22
Potash and phosphoric acid	14·03	14·82	14·42
Average ...	14·44	14·05	

A difference of 2 mds. per acre between individual treatment yields would have been significant. 20 lbs. nitrogen annually undoubtedly would have produced such a difference. In the 13 years a total of 805 lbs. per acre phosphoric acid (as super).has been applied to those plots receiving phosphoric acid, and 1,515 lbs. per acre potash (as sulphate) to the plots receiving potash. The treatment with lime, potash and phosphoric acid continued without nitrogen from 1922 to 1925, and with 40 lbs. nitrogen per acre to all plots, from 1926 to 1933 in the form of 3½ cwt. per acre dried blood except in 1933 when sulphate of ammonia was used.

In 1934 and again in 1935, 600 lbs. sulphate of ammonia per acre were given to all plots in the attempt to cause effects of potash or phosphoric acid deficiency to show up.

Bushes on the plots which have never had anything but nitrogen, so far, appear healthy and exhibit normal growth.

All the plots were heavily cut back in 1928. At no time has potash, prosphoric acid, or both, appeared to assist recovery after pruning.

Soil Acidity and Lime.

1. In the experiment last quoted, lime was applied to give a total of 1,700 lbs. pure lime per acre in the 13 years, of which about 512 lbs. have been neutralized by the sulphate of ammonia used in the last 3 years. From the results quoted it will be observed that the effect on crop of such small doses of lime is negligible, although the effect on soil acidity is significant.

2. The effects of single larger applications of lime in 1922 have also been observed in following years. The experiments were started on young tea (planted 1919) without preliminary records and each trial was replicated only five times. The occurrence of a small number of plots affected by "bad patches" makes the estimate of error high, but the accuracy is sufficient to show that small doses of lime have very little effect, although the biggest dose, enough temporarily to make the soil nearly neutral in reaction, has a distinct effect.

By 1924 the effects of lime had been small, and the yields in that year are quoted for comparison with the 1935 yields.

		Mds. tea per acre		Average pH of soil	
		1924	1935	1924	1934
1.	No manure	11·56	9·35	5·14	5·52
2.	15 mds. crushed limestone only in 1922	10·69	8·98	5·40	5·60
3.	No lime, 40 lbs. nitrogen annually ...	11·84	15·44	5·16	5·24
4.	15 mds. crushed limestone in 1922, and 40 lbs. nitrogen annually ...	11·94	15·68	5·50	5·32
5.	12½ mds. slaked lime in 1922, and 40 lbs. nitrogen annually ...	11·74	15·40	5·42	5·33
6.	30 mds. crushed limestone in 1922, and 40 lbs. nitrogen annually ...	11·73	15·80	5·65	5·37
7.	25 mds. slaked lime in 1922, and 40 lbs. nitrogen annually ...	11·17	15·14	5·61	5·40
8.	10 mds. crushed limestone in 1922, 1923 and 1924, and 40 lbs. nitrogen annually	11·67	14·44	6·02	5·51
9.	80 mds. crushed limestone in 1922 and 40 lbs. nitrogen annually ...	11·44	12·67	6·65	5·68
	Difference required for significance ...	...	1·85	...	...

Since 1927 nitrogen has been applied as sulphate of ammonia.

The smaller doses of lime have not affected crop, but the heaviest dose has produced a significant loss. Although the soil is now almost normally acid, it still contains excess lime.

Even the most heavily limed tea on this otherwise good soil is still much better than average tea, and the loss from liming would not be suspected but for the comparison with the unlimed soil. This is not an uncommon experience in practice where large dressings of lime have been applied artificially even when the surface soil is still under-acid. No case is known where tea has been successfully *planted* on soil not naturally acid. Even soils which have continued to grow good tea for years after heavy liming, have sometimes failed when eventually replanted.

3. A third trial to determine more accurately the effect of small changes in soil acidity were commenced in 1930, with 9 replications of each treatment, the preliminary treatment totals of 1929 being equalized.

Dressing in 1932	Mds. tea per acre		pH of soil	
	1929	1935	1931	1935
560 lbs. pure lime per acre (930 lbs. slaked lime) ...	15·70	15·36	6 00	5·52
No lime or sulphur... ..	15·81	16·36	5·53	5·38
400 lbs. sulphur	15·75	16·73	5·17	5·30
Difference required for significance	...	1·17		

The temporary nature of the change in soil acidity from the use of small dressings of lime or of sulphur is again indicated. 1,200 lbs. sulphate of ammonia per acre have been applied to all plots in the interval.

The effect on crop also is small. In early years there was no significant difference. Differences are greater in 1935 than in any previous year, in spite of the present small differences in soil acidity. Even in 1935, only the difference between the extremes, sulphur against lime, is significantly great.

4. It is only when lime dressings are very large that great effects on growth are observed.

We have not any sufficiently large area of tea available to make measurement of yield possible; but a number of small plots serve sufficiently well to demonstrate the effect of large dressings.

These plots, which were then occupied by tea, received respectively in 1922 no lime, 50, 100, 150, 200, 300 and 400 mds. per acre of crushed limestone. There was no obvious effect on the appearance of the tea after two years.

Bushes were then uprooted and new bushes planted. At the end of 3 years there was no obvious difference with dressings of up to 150 mds. crushed limestone per acre; but the bad effect of the heavier dressings was very marked. Half of each plot was then dressed with a quantity of sulphur calculated to be equivalent to the limestone previously applied. The sulphured halves then recovered, while the bushes on the heavily-limed but unsulphured plots continued to deteriorate.

In 1935 the most heavily limed areas contain only a few living bushes while even the more moderately limed areas show weaker growth than that of the unlimed area. The sulphured halves of the heavily limed plots grow normally good bushes.

Similar small scale demonstrations of the effect of very heavy dressings of sulphur in 1933 and 1934, on tea already established, now show reduced growth on the sulphured plots.

The differences in soil acidity are again found to become less with time.

Total sulphur per acre.	pH of soil	
	January 1935	October 1935
nil	5·30	4·90
500	4·50	4·15
1000	4·15	3·90
3000	3·65	3·70

Even on the most acid plots the tea is fully up to average in appearance, but is just noticeably poorer than the untreated tea.

As far as can be judged from examinations of large numbers of tea soils, tea is best suited by soils of pH between about 5.0 and 5.6, into which range the great majority of North East Indian tea soils fortunately fall.

Very few cases of soils of pH of less than 5.0 have been found. A considerable number (though a small percentage of the total area under tea) of soils on which tea grows poorly have been found to have acidities between 6.0 and 7.6. Most of these are from "bad patches" of small extent. In many such cases the presence of charcoal, or broken pottery, in the soil indicates contamination with wood ash, when the bad "condition" of the soil due to the deflocculating effect on the clay of soluble bases, is probably as big a factor in causing infertility as the low acidity.

Other cases are old white-ant (termite) hills. The soil of these is approximately neutral in reaction. The reason for their lack of acidity is undetermined, but they consist of yellow subsoil brought up from a considerable depth. All new deposits from rivers in North-East India are slightly alkaline, neutral or of low acidity. It is probable that the older soils which are good tea soils are acid only because the lime has been washed out of them, and it may be presumed that this lime accumulates in the subsoil, from which the termites build their mounds.

These mounds in their natural state will not grow tea, but an average case will carry good tea if treated with about 1½ ozs. sulphur per square yard, and given the plant food in which they are naturally deficient.

There are however a number of large areas, particularly in the Dooars, on which crops other than tea are good, but tea fails to grow. These are relatively recent flood deposits from rivers which have passed through limestone in the hills, and the only cause to which the failure of tea can be assigned is the presence of excess lime and magnesia. Any soil with more than 0.05% of lime soluble in one per cent citric acid solution must be looked upon with suspicion, though a soil rich in organic matter or clay may stand a little more lime and still do well under tea.

TULSIPARA EXPERIMENTAL PLOTS.

PRUNING.

9 treatments each 7 times replicated.

Preliminary treatment totals of 1930 equalized.

Experiment commenced in January 1931. Yields for 1931 averaged 3 mds. per acre on account of mosquito blight.

The following yields have since been obtained.

Plot-set	Mds. tea per acre				Total 4 years
	1932	1933	1934	1935	
Pruned annually					
3. Pruned December, without cleaning out	6·88	9·96	10·74	9·04	36·62
1. Pruned December with light cleaning out	7·27	11·20	10·94	10·28	39·75
5. Pruned December, stick pruned December 1930, since lightly cleaned out annually ...	5·80	10·16	9·51	10·28	35·75
7. Prunned mid-April (after first flush) with light cleaning out	5·39	9·82	8·45	7·34	31·00
Pruned in alternate years.					
4. As 1, but pruned December 1930, 1932, 1934 only ...	9·23	10·00	15·57	9·09	43·89
2. As 2, but pruned, December 1930, 1932, 1934 only ...	8·49	10·93	13·33	10·36	43·11
6. Stick pruned December 1930, pruned with light cleaning out December 1932 and 1934 ...	7·41	9·55	12·93	9·54	39·43
8. As 4, but pruned April 1930, 1932 and 1934 ...	10·37	9·62	15·39	7·86	43·24
Pruned at intervals of 18 months					
9. Pruned with light cleaning out June 1931. December 1932, June 1934	9·33	11·22	7·37	15·25	43·17
Difference required for significance	...	1·09	1·30	1·48	

The 1935 results taken alone provide no striking new information, but confirm previous results.

	Mds. tea per acre, 1935		
	Pruned on 1-year old wood	Pruned on 2-year old wood	Average of 14 plots.
Pruned December without cleaning out ...	9·04	9·09	9·07
Pruned December with light cleaning out	10·28	10·36	10·32
Pruned December with light cleaning out, 1931 and since : stick'pruned in December 1930	10·28	9·54	9·91
Pruned April after 1st. flush ...	7·34	7·37	7·35
Average of 28 plots	9·23	9·09	

Again as in 1933, there is no difference in yield whether pruning is on one-year-old or two-year-old wood, when both are plucked alike. When the tea is pruned there is a gain from cleaning out. In 1935 this gain persisted to the end of the season. In most years, at some date after mid-season, gain has ceased and loss has shown late in the season. It seems possible that this change is correlated with the degree and date of attack by mosquito blight. Mosquito blight was practically absent in 1935.

The bushes stick-pruned before the 1931 season, which showed heavy losses for the four following years, have practically recovered by 1935. Whether they will show any eventual gain remains to be seen. The pruning in April continues to show heavy loss. Although a good first flush is taken, the time wasted during the growing season is not recovered during the same year.

Neglecting 1931 when crops were almost negligibly small on account of terrible mosquito blight attack, two two-year cycles of pruning in alternate years have now been completed, and it is convenient to compare the results with those from annual prun-

ing. By considering averages of two years the experimental error is greatly reduced. At Tulsipara there is not such a close correlation between yields of successive years as there is at Borbhetta, but plots which do relatively poorly in one season tend to make it up in the next.

	First 2-year cycle average yields 1932 and 1933			Second 2-year cycle average yields of 1934 and 1935		
	Means of 7 plots		Mean of 14 plots	Means of 7 plots		Mean of 14 plots
	Pruned annually	Pruned in alternate years		Pruned annually	Pruned in alternate years	
Pruned Dec. no cleaning out	8·42	9·61	9·01	9·90	12·33	11·11
Pruned Dec. with light cleaning out ...	9·76	9·71	9·73	10·61	11·84	11·22
Pruned Dec. with light cleaning out since 1930; but stick pruned 1930 ...	7·98	8·48	8·23	9·90	11·23	10·57
Pruned April after first flush with light cleaning out ...	7·60	10·27	8·93	7·90	11·62	9·76
Averages of 28 plots ...	8·44	9·52		9·57	11·78	
Difference required for significance						
Between averages of 7 plots	1·10 mds.			1·02 mds.		
Between averages of 14 plots	0·78 „			0·72 „		
Between averages of 28 plots	0·55 „			0·51 „		

Leaving tea unpruned in alternate years.

In both cycles there is a significant gain compared to annual pruning. When however the tea is cleaned out, annual pruning does as well as alternate-year pruning in the first cycle, and only just siginficantly worse in the second cycle.

The gain from leaving unpruned is greatest when the tea is pruned late (April). There is yet no sign of deterioration from leaving tea unpruned.

Cleaning out.

Light cleaning out shows significant gains on annually pruned tea in most years but not in all. Its good effect is always great on early crop, but the effect ceases and is usually reversed late in the season. This is believed to be due to the comparative immunity to mosquito-blight attack of bushes not cleaned out. In 1935, when mosquito was absent, the gains from cleaning out persisted.

On tea pruned in alternate years, there has been no gain from cleaning out.

The drastic stick-pruning prior to the 1931 season has produced significant losses: but in 1935 the bushes may be considered to have recovered.

April pruning.

In spite of giving a big first flush, the following loss of part of the growing season is not made up in the same year. If the tea is left unpruned in the following season, this loss is made up in that season. If pruning is annual, loss from late pruning is annual.

Pruning at intervals of 18 months.

Two more years are required before two cycles are completed.

We can however observe the effects over the last four years compared with both annually-pruned and with alternate-year-pruned tea, all lightly cleaned out when pruned.

	Mds. tea per acre				Total
	1932	1933	1934	1935	
1. Pruned Dec. 1930, 1932, 1934	8·49	10·93	13·33	10·36	43·11
2. Pruned Dec. annually ...	7·27	11·26	10·94	10·28	39·75
3. Pruned June, 1931, Dec. 1932 June 1934	9·33	11·22	7·37	15·25	43·17

In 1932 tea (No. 3) pruned at 18-month intervals, was unpruned after pruning in the June of the previous season and it gives much more than the annually pruned tea (No. 2) and a little more than the tea pruned six months earlier (No. 1).

In 1933 after pruning on 18-month-old wood it gives the same crop as the tea pruned at the same time either on 12-month-old or 24-month-old wood. This appears general as is it occurs also at Borbhetta.

In 1934 when pruned in the growing season it, of course, loses crop heavily.

In 1935 when unpruned it yields much more than the other two, both of which were pruned, and roughly makes up the loss made in 1934 compared to tea pruned in alternate years.

	Total crop 1934 and 1935, mds. tea per acre.
Pruning at intervals of 2 years ...	... 23.69
,, ,, ,, ,, 1½ ,, ...	... 22.62
,, ,, ,, ,, 1 ,, ...	... 21.22

Over the complete three-year cycle 1933, 1934, 1935 crops are not significantly different whether tea is pruned annually or at 18 months intervals.

	Total crop, 3 years.
Pruning at 18 months intervals ...	33.84 mds.
,, ,, 12 ,, ,, ...	32.48 ,,

There appears therefore to be no objection to June pruning so long as the bushes are left unpruned in the following year to make up the loss which must be made in the year of pruning.

Plucking.

9 treatments each 7 times replicated.

Preliminary treatment totals of 1930 equalized.

Fifth year of continuous treatment.

Weekly plucking.

Plot-set	Style of plucking	Mds. tea per acre averages of 7 plots. 1935
1.	6″ initial growth then to janam	12·26
2.	8″ „ „ „ „ „	11·11
3.	6″ „ „ „ a big leaf once only ...	11·95
5.	8″ „ „ „ „ „ „ „ „ ...	10·74
4.	6″ „ „ „ „ „ „ till mid-August ...	10·33
6.	4″ „ „ „ „ „ „ throughout season	8·67
	Difference required for significance between averages of 7 plots	0·92

Influence of initial growth and of leaving a leaf.

	Plucking to janam	Plucking to leave a leaf once only	Average of 14 plots.
Initial height 6″ ...	12·26	11·95	12·10
„ „ 8″ ...	11·11	10·74	10·92
Average of 14 plots ...	11·68	11·34	

Between averages of 14 plots a difference of 0.65 mds. is significant.

Whether a leaf is left (once only) or not, is not now affecting crop significantly, although losses from leaving the leaf in early years were considerable. Loss from leaving the longer initial growth still continues to be significantly great. This also was the experience in the similar experiments at Borbhetta. The leaving of a leaf does appear so to strengthen a bush that it yields as well as the harder plucked bush after some years. No

such relative improvement appears from leaving longer initial growth.

When a big leaf continues to be left more than once only, losses of crop continue to be significant. The 4″ plucking yields a big early crop, but as bushes get more and more leafy from continual leaving of leaves, crop falls away badly.

	Mds. tea per acre 1935						
	To end May	June	July	Aug.	Sept.	Oct.	Nov.
6″ to janam	0·79	1·17	1·48	2·61	2·52	2·63	1·03
6″ then a big leaf once only	0·75	1·02	1·46	2·61	2·57	2·61	0·91
6″ then a big leaf till mid-August	0·75	0·96	1·15	2·02	2·07	2·63	0·76
4″ then a big leaf throughout season	1·20	0·99	1·26	1·75	1·60	1·53	0·43

Effect of varying intervals between pluckings.

All plucked at 6″ to janam.

	Mds. tea per acre 1935
7 days, with breaking back	12·26
10 „ „ „ „	12·37
10 „ without „ „	11·83
14 „ „ „ „	10·73
Difference required for significance ...	0·92

It makes no significant difference to crop whether bushes are plucked at intervals of 7 or 10 days. Breaking back also makes no significant difference.

Extending the interval to 14 days produces a significant loss of crop. Although every care is taken to maintain the same standard of plucking, and the percentage of two-leaves and a bud varies little, the leaf from plucking at longer intervals is, of course, coarser.

Cultivation.

(1). Trial of (*a*) deep cultivation in cold weather;

(*b*) different methods of suppressing jungle in rains.

8 treatments each 5 times replicated.

Preliminary "treatment totals" of 1930 equalized.

Fifth year of similar treatment.

Yields in mds. tea per acre 1935.

Plot-set	Light cultivation	With deep hoe in January	Without any cultivation in cold weather	Averages of ten plots
1.	8 Light hoes annually ...	8·22	7·74	7·93
2.	4 " " " ...	6·87	6·18	6·52
3.	8 Rounds surface scraping ("Cheeling") ...	8·20	7·47	7·89
4.	8 Rounds sickling ...	6·24	6·63	6·44
	Averages of 20 plots ...	7·36	7·01	

Deep Cultivation.

The differeuce required for significance between averages of 20 plots is 0.65 mds. tea per acre. The difference due to the deep hoe is not significant.

This result is rather surprising. We may accept it as true, from results at Borbhetta, that no benefit accrues from the deeper stirring of the soil entailed by deep hoeing: but, at Tulsipara, the plots not deep-hoed get no cultivation at all between October and March, and benefit from the extra round of cultivation given in January to the deep hoed plots would be expected since it should keep them cleaner of weeds, particluarly with treatments 2 and 4 which do allow the growth of considerable jungle.

If the results be examined it will be observed that treatments 1, 2 and 3 do give better yields with a deep hoe than without a deep hoe, although the differences between the means of five plots only are not significant within the error of the experiment.

No definite statement can be made on the evidence of the figures obtained, but from examination of the plots it is believed that while treatments 1, 2 and 3 do lose a little from the absence of the January hoe, yet treatment 4 actually gains from the absence of the deep hoe, because when examined in April the plots not deep hoed were actually less weedy than the plots which were deep hoed. These plots which are only sickled so that the soil is never disturbed at all unless deep-hoed, grow tea roots very close to the surface; and, it is suggested as a possibility to be watched that just as the presence of weeds reduces the growth of tea, so the occupation of the surface soil by tea-roots reduces the growth of weeds. Further the application of a deep hoe not only puts the surface roots of tea out of action, but leaves a good seed-bed in which weeds establish themselves, before the pruned bush clothes itself with leaves to provide weed-suppressing cover.

Light Cultivation.

The difference required for significance between averages of 10 plots is, 0.915 mds. tea per acre.

There is no significant difference in crop whether weeds are suppressed by light hoeing, stirring the soil to several inches, or by scraping ("cheeling") off surface weeds without disturbing the soil.

When the number of rounds of light hoeing is reduced to four (March, May, July and September) the land gets weedy between rounds, and crop is significantly reduced.

The plots of this cultivation experiment at Tulsipara are not manured and the tea is beginning to get poor and to provide little cover even on the naturally good patches of soil.

Sickling only keeps weeds always low, but leaves the soil occupied by roots, and the effect on crop is the same as that of allowing the land to get dirty and then hoeing at intervals of two months.

MANURING.

(1). Nine treatments.

7 blocks were originally laid out, each containing the 9 treatments.

6 of these blocks are on normal soil and carry fairly even tea. The seventh block is partly on a ridge of gravel on which growth is very poor, and response to manuring is much less than on normal soil.

It is considered therefore to give a better estimate of the effects of manuring to leave the stony block out of account, and to judge on six replications only, using the preliminary records of 1930 to adjust final yields and to obtain the estimate of error using the analysis of co-variance.

Crops in 1935 were :—

Plot-set	lbs. per acre annually since 1931			Mds. tea per acre 1935
	Nitrogen	Phosphoric acid	Potash	
1.	0	0	0	10·28
2.	40	0	0	12·04
3.	40	0	40	12·06
4.	40	0	80	12·33
5.	40	40	0	12·04
6.	40	40	40	12·02
7.	80	0	0	13·09
8.	80	0	80	13·03
9.	80	0	160	13·40
Difference required for significance				0·98

Neither potash nor phosphoric acid is having any significant effect on crop.

The effect of nitrogen is significant. 40 lbs. per acre annually in the fifth year of application gives 1.8 mds. tea per acre more than no manure : while 80 lbs. nitrogen give 2.9 mds. per acre more tea than is obtained without manure, and 1.1 mds. more than in obtained with 40 lbs. nitrogen.

These differences are small compared to what is obtained at Borbhetta from the same manuring, neither do we get at Tulsipara increased crops proportional to the dose of nitrogen, as we do at Borbhetta. The differences however are increasing.

(2). Trial of cattle manure against artificial mixture.

3 treatments, 3 times replicated with preliminary records in 1930.

(1). A mixture of soluble artificials providing 40 lbs. nitrogen 40 lbs. phosphoric acid and 40 lbs. potash and (2) cattle manure at 5 tons per acre (which on analysis has always contained about 100 lbs. nitrogen, about 60 lbs. phosphoric acid and 50 lbs. potash) are tried against (3) no manure. Application of manures has been annual since 1931.

		Mds. tea per acre 1935.
1. Artificial	...	12.12
2. Cattle manure	...	11.06
3. No manure	...	9.74
Difference required for significance	...	1.18

Both manures are significantly better than no manure. The artificial is not quite significantly better than the cattle manure.

Trenching.

The results in 1935 record the effect of operations in January 1934. During season 1934 neither the trenching nor the manuring exercised any effect.

The actual average yields (of 6 plots of 200 bushes each devoted to each treatment) have been during season 1935.

	Mds. tea per acre 1935			
	With 10 tons cattle manure per acre	Without manure	Average of 12 plots with different cultivation	
Ordinary deep hoe ...	11·34	11·56	11·45	
V-shaped trench 9″ deep between every line of bushes	11·16	10·99	11·07	
Rectangular trench 18″ deep by 9″ wide between alternate line	11·05	10·56	10·80	
Average of 18 plots with and without manure	11·18	11·04	11·11	General average

The arrangement of plots used is a Latin Square, with which arrangement it is not possible to equalize the yields per set of plots before treatment.

The yields per plot-set in 1933, when all 36 plots were treated alike, were :—

Cold weather cultivation in 1934	Mds. tea per acre 1933			
	Average of 6 plots manuring in 1934		Average of 12 plots	
	10 tons cattle manure per acre	Nil		
Ordinary deep hoe ...	9·42	9·55	9·48	
V-shaped trench, 9″ deep between every line of bushes	9·50	9·29	9·40	
Rectangular trench, 18″ deep by 9″ wide between alternate line	9·33	9·14	9·23	
Average of 18 plots ...	9·42	9·33	9·37	General average

It will be observed that yields in 1935 after treatment are much in the same order as in 1933 before treatment.

Using the preliminary yields of 1933 to adjust the final yields of 1935, by the method of analysis of co-variance, we get the following comparable figures :—

Cultivation treatment in 1934.	Adjusted yields 1935. Average. Manuring in 1934		Average of 12 plots.	
	10 tons cattle manure per acre.	Nil.		
Ordinary deep hoe	11·29	11·35	11·32	Difference required for significance between averages of 12 plots. 0·56
V—shaped trench, 9″ deep between every row ...	11·00	11·09	11·05	
Rectangular trench 18″ deep by 9″ wide between alternate rows ...	·1100	10·85	10·92	
	11·10	11·10		
Difference required for significance between means of 18 plots ...	= 0·45			

It is quite clear that the cattle manure has exercised no effect whether broadcast and deep hoed in, or buried in either type of trench. This tea appears to obtain, from the unassisted soil, all the food it can use. The yield from the unmanured plots is, of course, very good.

With regard to the effect of the trenching there appears to a slight bad effect increasing with the depth of the trenching; but the maximum difference, that due to the 18″ trenches, cannot be considered as definite, in view of the calcutated error of the experiment.

Spraying.

Red spider or other disease being practically absent, no experiments were made on this subject in 1935.

HALEM TEA ESTATE.

MANURING.

These experiments are conducted on 21 half-acre plots divided into 7 blocks of 3 plots each.

The treatment of two of these blocks has been irregular so that hitherto they have omitted from consideration. The other five blocks (15 plots) have received the following treatments annually since 1933.

On these five blocks, results over the past three years have been :—

Annual treatment per acre.	Mds. tea per acre.		
	1933	1934	1935
16000 lbs. cattle manure	10·46	11·17	13·30
340 lbs. artificial mixture	10·52	11·53	13·87
No manure	9·83	10·30	12·28
Difference required for significance ...	0·72	0·69	0·66

Compared to no manure, the increases due to manuring have been :—

	1933	1934	1935
Cattle manure ...	0.63	0.87	1.11
Artificial ...	0.69	1.20	1.59
Difference required for significance ...	0.72	0.69	0.66

In 1933 the difference due to neither manure was quite great enough to be considered significant. As the experiment progresses the cumulative effect of manuring causes the differences due to manuring to be greater; while, as the plots tend to even up, the error of the experiment becomes less. We have not, in this case, the advantage of preliminary yields when plots were

all treated alike. In 1934 and in 1935 the difference in crop due to either manure is definitely significant, in spite of the fact that this good young tea on good soil, well shaded, is still increasing in yield when unmanured.

The artificial manure is gaining on the cattle manure, but even in 1935 the difference of 0.48 mds. tea per acre in favour of the artificial against the cattle manure is still not great enough to be accounted significant, having regard to the calculated error of the experiment.

In order to increase the accuracy of the experiment in the future, two more blocks were added in 1934.

On these, the manured plots received in 1934 double the manure dressings applied to the first 5 blocks to make up for the absence of manure in 1933. In 1935 the respective manures to all 7 blocks were alike.

In a few years time the difference in early treatment will not be affecting results, and we can consider that we have 7 replicates of each of three treatments. For the 1935 results we cannot consider such an assumption to be strictly accurate, but we can allow some weight to the evidence provided by these two new blocks, particularly for the comparison between sulphate of ammonia and cattle manure, since any advantage accruing to the one by getting a double dose in 1934, instead of single doses both in 1933 and 1934, will also affect the other in a similar manner.

Average yields in 1935 from all seven blocks were :—

		Mds. tea per acre 1935.
Cattle manure	...	13.38
Artificial	...	13.87
No manure	...	12.33
Difference required for significance	...	0.47

The lower estimate of error obtained from the use of seven replications indicates that the gain of 0.49 mds. more tea per

acre from the use of the artificial than from the use of the cattle manure is significant.

It is probable, then, that the artificial has, so far, given better results than the cattle manure.

The artificial has provided per acre annually—

40 lbs. nitrogen.
20 lbs. phosphoric acid.
20 lbs. potash.

The cattle manure used has each year been carefully sampled and analysed. The 16,000 lbs. per acre applied annually supplied :—

	1933	1934	1935	Annual average
lbs. nitrogen per acre ...	103	117	92	104
„ phosphoric acid per acre ...	82	53	43	59
„ potash „ „ ...	62	66	55	61
„ dry organic matter „ ...	2500	2488	1843	2277

312 lbs. nitrogen as cattle manure have given 2.61 mds. tea.

120 lbs. nitrogen as ammonia have given 3.48 mds. tea.

So far, the artificial is clearly the more efficient per unit of nitrogen.

	Mds. tea per 100 lbs. nitrogen.
Cattle manure ...	0.83
Artificial ...	2.90

Comparison on price, at Halem, where careful accounts of all expenditure have been kept, including freight, carting, and application, is not favourable to the artificial.

3 dressings of cattle manure costing Rs. 24/6/- give 2.61 mds. tea.

3 dressings of artificial costing Rs. 45/- give 3.48 mds. tea.

		Total mds. tea per Rs. 10/-.
Cattle manure	...	1.07
Artificial	...	0.77

So far, the cattle manure, at its cost at Halem, has paid better than the artificial, though, at present prices for tea it is doubtful whether either yet shows a profit on this tea which is so good, unmanured.

In the cost of the cattle manure only the costs of carting and application are charged. The cost of collection is (correctly) debited to the necessary cleaning of lines. Together with the dung it would be well to collect from the lines all urine-soaked bedding and other organic rubbish close at hand for composting with the dung. The application of such cheaply collected material must pay on most gardens though normally it will deal with only a small fraction of the garden's manure requirements. The balance generally will be more cheaply and efficiently applied as artificial, than as organic material collected from greater distances, when the cost of collection has to be charged to the manure.

BEHORA TEA ESTATE.

MANURING.

Here there are 5 trials which, although conducted only in duplicate (using ten half-acre plots) are on tea naturally so very even, that results are unusually accurate. In 1930 when all were unmanured all pairs of plots yielded practically alike.

1935 is the sixth year of continuous application of—

Sulphate of ammonia to supply 60 lbs. nitrogen annually.

Concentrated superphosphate to supply 40 lbs. phosphoric acid annually.

Sulphate of potash to supply 40 lbs. potash annually.

	Yield 1935 mds. tea per acre.
Nitrogen only	15.03
Nitrogen and phosphoric acid ...	15.46
Nitrogen and potash ...	15.16
Nitrogen, phosphoric acid and potash	14.69
No manure	10.89
Difference required for significance	1.15

Nitrogen alone produces a very significantly increased crop, but the differences due to the use of potash, phosphoric acid, or both, do not approach significance.